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Racial Doctrine and Social Evolution

IN the now not inconsiderable list of men of eminence in anthropological studies who have paid tribute to the work of Thomas Henry Huxley in the Huxley Memorial Lecture of the Royal Anthropological Institute, now approaching near to its fortieth year of delivery, no one, since the inaugural lecture in 1900 by Lord Avebury, the intimate friend of both Huxley and Darwin, has been more felicitous or more opportune in the choice and treatment of subject than was Prof. H. J. Fleure, when on November 9 he addressed the Institute on "Racial Evolution and Archæology" (see page 981). In making the classification and distribution of races the basis of his argument, he dwelt on an aspect of the study of man with which Huxley was closely concerned, and at the same time, by associating racial studies with the results of archæological and cultural research, he was able to draw certain inferences as to the forces making for the upward progress of mankind, which would have commended themselves to one whom Prof. Fleure and his colleagues without exception would regard as their master.

Prof. Fleure struck the keynote of his lecture when in his opening sentences, speaking of Huxley, he said : "His championship of the free conscience is more than ever needed to-day, when in not a few countries the pursuit of the science of man is being seriously affected by non-scientific views." The evil, however, as Prof. Fleure went on to show at a later stage in his lecture, is even more grave than these words would suggest. It is not merely that racial theory is being constrained to lay false emphasis on the part played by the racial factor and by certain races in the advancement of civilization, as well as on the character and standing of those races, but also racial doctrine is made the instrument of attack on that freedom of conscience, of which it was Huxley's conviction that the process of growth is in a very deep sense the essence of progress in the development of civilization. The call of the blood—in other words, the claims of the group—are made to transcend and override personal right to the exercise of individual judgment.

The conflict between authority and the right to individual judgment, in which Huxley and other great figures of the latter half of the nineteenth century were so long and strenuously engaged, had seemed to be won—fully in the field of science, where truth alone, without regard to prepossessions resting on extraneous consideration, was accepted universally as the acid test of validity. It is unnecessary to recall the course of events by which, since the Great War, science in certain countries has been harnessed to political ideals of varied complexion ; but the perversion of ethnological science to support the authority and supremacy of the group over freedom of thought and judgment has been tragic in its consequences, both socially and in the field of science.

In his survey, vast in space and time, of the evolution of races and of their migrations over the surface of the globe, and of the part played by these races, each in their turn, in the development of civilization, Prof. Fleure was in a position to demonstrate that the history of mankind is a story of the development of individuality and its emancipation from the chains of the social group, which, indeed, he suggested may perhaps be traced back as a relic of even pre-human days. In every phase of cultural growth, from the stage of the food-gatherer to the higher forms of

civilization, there is evidence of "an increasing purpose". So far from society being, as the political philosophers would have it, a system of restraints imposed upon the original freedom of man in his natural state, the history of human progress, as Prof. Fleure interprets the evidence, is the story of the emancipation of the individual conscience from the suppressive influence of group pressure, which favours mediocrity alone.

Nor does the theory of the superiority of the racially homogeneous group as a progressive force receive any support from racial history. As anthropologists generally hold, and as Prof. Fleure agrees, it is probable that no society, at least of any size, is composed of a racially homogeneous group, nor has been so composed since at least the days of the food-gatherers. Further, as Prof. Fleure went on to point out, in a society composed of racially heterogeneous groups, such as have been formed in the course of the kaleidoscopic movement of racial migration which has been taking place for thousands of years, there is evidence to show that adjustments and compromise have taken place between the different groups, each of which has had its own racial history behind it, and, possibly, each with its own characteristic mental attitude and outlook.

From the conflict, however, which thus arises, when the ritual of one part is set over against the ritual of another, discussion takes place, and as Prof. Fleure puts it, leads to the valuing of justice rather than ritual. This must have happened even with such a military caste as the Nordics, whom a perverted racial theory has elevated to a pinnacle which is less than deserved. For even in the larger groupings which seem to have come about through the domination of tillers by herders, especially when the latter have been of a militarizing tendency, the group developed with a diversity of tradition and with diverse ranks of a hierarchical society, and nearly everywhere the result has been that the immigrant rulers have had to accommodate themselves to the prejudices and customs of the subject masses.

It would appear, in fact, that the dogma of the political philosopher that the development of society is from status to contract, when interpreted in the light of the evidence of ethnology and archæology, must be taken to mean that in the development of civilized society the line of progress has been, not a class conflict, but in the direction of an ultimate adjustment of rights and privileges among those varied sections of society, which may in fact be rooted in diverse racial origins and are certainly linked with differences of tradition and social outlook. Such an adjustment to be lasting cannot be imposed by superior authority but must be the result of free and unfettered discussion.

"What does not Britain owe", asks Prof. Fleure, "to the fact that Celtic, Teutonic and Romance cultural contributions to the common life have intertwined without complete dominance by any one of them ?" He points out that, in the instance of Holland, which welcomed the persecuted, we marvel at the richness of development of individuality in a society orderly above the average of its time and not particularly distinguished as a whole.

On a view of the history of human development such as has been put forward by Prof. Fleure, there cannot be two opinions but that the verdict lies in favour of the racially heterogeneous rather than the homogeneous group. But what of the future ? Will the unity of purpose and action of a society, which exacts uniformity in composition, culture and social ideal, prevail over the weaknesses inherent in its denial of what history has shown to be the evolutionary trend ? On such a question we cannot do more here than refer to the conclusion at which Prof. Fleure has arrived. If the group working towards 'autarky' by the suppression of thought and intellectual intercourse loses its perspective, throwing out its best workers, thinkers and artists in the interest of mediocrity, strongly tinged with jealousy, it loses the means of keeping in contact with the ceaseless process of change. Further, by the suppression of the principle of freedom of conscience, it becomes an anti-scientific authoritarianism, because it denies that "which is the life-breath of science."

Such, then, is the verdict of detachment—the view of the anthropologist, who from his survey of the trends of development in civilization throughout the great expanses of space and time of man's history, is brought to the conclusion that in freedom alone, freedom of development and freedom of expression, does truth, material, moral and spiritual, emerge. To this may be added as a legitimate corollorary that the aim of society must be to ensure not its own formal permanence, which is the triumph of the machine, but the maintenance of such conditions as will best keep open a way for man to the attainment of his ultimate destiny, whatever that may be.

Physics of Music

(1) Science and Music

By Sir James Jeans. Pp. x + 258 + 10 plates. (Cambridge: At the University Press, 1937.) 8*s*. 6*d*. net.

(2) Music and Sound

By Ll. S. Lloyd. Pp. xiv + 181. (London: Oxford University Press, 1937.) 10*s*. 6*d*. net.

THE increase in the appreciation of music in Great Britain, and the importance of a knowledge of acoustics for such purposes as the control of noise and the design of public halls, make the appearance of two books on this subject extremely opportune. There is, however, a fundamental difference between them. Sir James Jeans approaches the reader who has no technical knowledge and interests him in music and its associated physics alike; but Mr. Lloyd addresses the musician, and leads him on to scientific principles for the sake of the understanding that he will thereby gain.

(1) It is true that "Science and Music" is eminently readable and contains no mathematical symbols; but that seems to impose no limitations on the author: his discussion of the physical principles is clear and satisfying. He is equally at home when discussing the countless details on which music depends, or the recent investigations into the measurement of reverberation. On the purely musical side the book is full of good matter, and could only have been written by an expert familiar with orchestral instruments.

The book begins with a fascinating account of the development of the ear, and then describes the fundamental facts about frequency, beats, resonance, the vibrations of a stretched string and harmonics. There follows an account of the factors which govern the tones of the piano and other stringed instruments. We have an analysis of the physical conditions which produce the Stradivarius quality of a violin; the author even hints that X-ray analysis may in time lead to its mass production.

After a study of the vibrations of air, we have a description of edge-tones and the way in which the eddies produced control the sound of a flue organ-pipe; reed pipes follow and then applications to the chief wind instruments of the orchestra. Interesting light is thrown on many of their problems, including their characteristic timbre and the way in which pitch can be varied by the player's lips. Perhaps in a future edition it may be explained how the sound of a clarinet, owing doubtless to the reed, contains a second harmonic of 3·5 times the amplitude of the fifth (p. 150) and yet the instrument will overblow to the fifth harmonic and not to the second.

Another chapter is devoted to discord and the origin of the musical scale, with an account of the various attempts to overcome the difficulties of equal temperament; it is only when the reader finishes the chapter that he realizes that he has been taken through a series of subjects that in less able hands would have been very severely technical. (There is an obvious slip in the top line of p. 143, for the wolf-fifth contains about 7·4 semitones.)

The last two chapters handle the transmission of sound from its source to the ear-drum and its transmission from the ear-drum to the brain. In spite of a still current impression to the contrary, the problem of constructing a public hall with good acoustic properties has been solved, and we have a clear account of the effect of various materials upon absorption: incidentally, the marked musical superiority of wood over felt or canvas of equal absorbing power in the middle register is explained as due to less damping of the higher notes and of the harmonics; music will therefore sound brilliant and rich in a wooden room, but dull and dead when the damping is produced by felt and canvas.

When we come to the discussion of the processes in operation between the ear-drum and the brain, with their many subsidiary questions, we have the author at his best: among many interesting facts we learn how in many of our radio sets all frequencies below middle *C* are cut out; yet we hear the double-bass strings and male voices with absolute clearness.

The value and attractiveness of the book are increased by an exceptionally good series of photographs and diagrams. It will fascinate those interested in music and will be very useful to physical students for its account of the modern work upon sound.

(2) In the introduction to "Music and Sound", it is rightly pointed out that, while a knowledge of acoustics is useful to the musician, the scale has been developed by composers, and the indications from physics can only be accepted when they agree with what counterpoint teaches: a composer should learn to think in terms of the pure scale and must therefore study music of the polyphonic period, when music was written for unaccompanied voices.

The book begins with a satisfying investigation of major and minor scales and the effect of modulation in displacing the notes. Then come discussions of temperaments, mean-tone and equal; and of chromatic notes, decorating notes and intonation, a number of the results, such as the difference between $F\sharp$ and $G\flat$, being worked out in commas.

In Chapter iv, combination tones and beats are handled in an interesting way, from the point of view of the concert-room rather than the laboratory. But at first sight one point is rather puzzling. The author on p. 40 accepts Helmholtz's view and holds that combination tones are produced in the ear, yet he says on the previous page that experiment confirms a general observation denying it. The author next deals with consonance, dissonance and the effects of mistuning, and his specialist knowledge leads to some striking remarks. Thus on p. 64:

"the major chord of the 6/4 is acoustically the smoothest consonance, yet for centuries the art of music has treated this chord as a discord. There is a significant sentence in Helmholtz's work: 'The dispute as to the consonance or dissonance of the fourth has been continued to the present day'. This dispute is, in effect, whether music is an art or a science. No room for controversy would have been left had the test of the disputants been that of the use of the 6/4 by Bach in his forty-eight preludes and fugues for the clavier."

The handling of musical notes, audibility and resonators is on ordinary lines and is followed by an excellent chapter on the organ pipe and orchestral instruments. In spite of the limitations imposed by the holes and valves of the wind instruments of an orchestra, it is satisfactory to have it on Stanford's authority that in the orchestra the compromise of 'equal temperament' has no place.

The author lays stress on the drawing of graphs in order to obtain a concrete grasp of acoustic principles, and in the last chapter gives a good example of their value in discussing the vibration of strings. Having excluded from the text all but the most elementary mathematics, he provides for further information a number of short appendixes, the last being an excellent note on auditoriums.

The book is obviously written by a trained musician; its style is clear and its mode of presentation fresh. It is strongly to be recommended to those for whom it is written.

G. T. W.

Recent Work in Enzyme Chemistry

Enzyme Chemistry

By Dr. Henry Tauber. Pp. xii + 243. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 15*s*. net.

CONSIDERING the complexity of the problems presented by enzyme chemistry and the remarkable achievements which have been made of late in this branch of biochemistry, there is little doubt that the appearance of a book describing accurately and concisely recent advances would be very welcome. Dr. Tauber has attempted this somewhat formidable task. His book, as the author states in his preface, "makes no claim to completeness", whilst theoretical considerations are intentionally reduced to a minimum. Presumably the book is to be read as an addendum to more complete works on enzyme chemistry.

After a short introductory chapter dealing very briefly with such topics as enzyme specificity, activators and inhibitors, reversible inactivation, the carrier theory, and the mechanism of enzyme synthesis, the author turns to the descriptive work which forms the main feature of his book. He deals first with esterases and then, more at length, with the proteolytic enzymes. Here there is to be found a good description of the work of Northrop and his colleagues on the crystallization of members of the proteinase group (pepsin, trypsin, chymotrypsin, etc.), and a not too adequate description of the recent work of Bergmann and his associates. The author, for example, states (p. 87) that "it is not known whether papain is a single enzyme or a mixture of two or more enzymes", whereas Bergmann and Ross (*J. Biol. Chem.*, **111**, 659; 1935) make it clear that there must be in natural papain two different proteolytic enzymes, a proteinase and a polypeptidase, the former of which is reversibly inactivated by oxidation and the second irreversibly inactivated (see also Bergmann and Ross, *J. Biol. Chem.*, **114**, 717; 1936). The author then turns to the amidases, lightly touching upon such enzymes as asparaginase, aspartase and tyraminase, and giving more attention to the preparation and some of the properties of urease and arginase. Carbohydrases are next dealt with and finally oxidizing enzymes and systems are described. Catalase, carbonic anhydrase and luciferase are distinguished by each having a separate chapter.

Dr. Tauber cites (p. 162) as the first experimental proof of the formation of an intermediary enzyme-substrate compound the reaction between catalase and monoethylhydrogen peroxide described by Stern. Keilin and Hartree, however, claim (*Proc. Roy. Soc.*, B, **121**, 173; 1936) that ethylhydroperoxide is not a substrate of catalase, no decomposition (to acetaldehyde) taking place with a weak solution of the enzyme free from other hæmatin compounds and from alcohol.

Dr. Tauber describes the dehydrogenase systems scrappily and inadequately. Keilin is credited with the conclusion (p. 169) that "the succinic enzyme is a complete enzyme system consisting of a dehydrogenase, cytochrome, and the oxygen-activating indophenol (or cytochrome) oxidase". The finding of Banga, Laki and Szent-Györgyi that the oxidation of β-hydroxybutyric acid to acetoacetic acid is due to the same enzyme-co-enzyme system which oxidizes lactic acid (p. 172) is quoted without the additional statement that these authors (*Z. physiol. Chem.*, **220**, 278; 1933) afterwards retracted this conclusion. It is now known that the two systems are distinct. There is little mention of the properties of the amino-acid dehydrogenases.

Confusing and inaccurate statements and misspellings appear—evidence, doubtless, of hasty proof-reading. For example, we find the following sentence, "Tyrosine, monophenols and aromatic diamines are not attacked" by laccase (p. 186), whereas, of course, such monophenols as guaiacol and *p*-cresol, as the author has actually previously mentioned, are attacked by laccase.

There is a number of omissions of subjects which certainly should have found some mention in this book; for example, glyoxalase and the co-enzyme properties of glutathione, action of eserine on choline esterase, protective power of substrates and allied compounds on enzyme inactivation by dyestuffs, etc., equilibria established by xanthine oxidase, etc., recent concepts of constitutive and adaptive enzymes. Quite apart from these and other omissions, however, it is evident that Dr. Tauber's book requires some revision, and it is to be hoped that he will be able to accomplish this in the not too distant future.

J. H. Q.

Human Embryology

A Textbook of Embryology

By Prof. H. E. Jordan and Prof. J. E. Kindred. Third edition. Pp. xiv + 613. (New York and London: D. Appleton-Century Co., Inc., 1937.) 25*s*. net.

THIS text-book by two Virginian embryologists has served a useful purpose in the past and will continue to do so in the future. It deals more particularly with human development, and the comparative method in deducing and interpreting the progressive changes is used but sparingly, the authors preferring generally to fill in lacunæ in our knowledge by postulating hypothetical stages rather than by referring to data derived from the study of other animals. In special cases, however, and more especially in describing the development of the fœtal membranes and their appendages, the comparative method is freely adopted. Furthermore, in the interpretation of vestigial and transitory structures full use is made of the 'law of recapitulation'. The separate section on "Laboratory Exercises" continues to be a feature of the work. The present edition does not differ materially from the last, but there are some additions, more particularly to the chapters on hæmopoiesis and sex determination, and certain errors in other parts of the book have been corrected.

Of the errors which have been allowed to remain, those relating to ovulation, the corpus luteum and the sexual cycle are perhaps the most noticeable. Thus, the corpus hæmorrhagicum is described as the mass of clotted blood which fills the cavity of the ruptured ovarian follicle and constitutes the first stage in the formation of the corpus luteum. The name 'corpus hæmorrhagicum' or 'blood follicle' is now reserved for degenerate undischarged follicles which have never ruptured, and in the figure such a one is shown in the *centre* of the ovary and duly labelled. The lutein cells can scarcely be said to "invade the corpus hæmorrhagicum" since they are actually formed from the undischarged follicular epithelium, and the cells which grow inward from the wall are connective tissue elements, these giving rise to a network surrounding the enlarged lutein cells.

Again, in dealing with the time of ovulation, the authors cite Siegel's statistical data pointing to the occurrence of the process about the tenth day after the beginning of the menstrual flow. They omit to mention the work of Shaw, Knaus, Ogino and others and the more recent work of Hartman showing definitely that in a normal menstrual cycle ovulation usually takes place about the fourteenth day. Moreover, the œstrous cycle is incorrectly described. The diœstrus is not simply a quiescent period, but is now known to be of the

nature of an abbreviated pseudo-pregnancy. The authors confuse the dicestrus with the prolonged period of rest known as the ancestrus and are wrong in stating that in moncestrous animals the dicestrus includes almost the whole year, for such species do not experience a dicestrous period. Moncestrous animals are not those which experience "only one annual heat period", for the dog is definitely moncestrous (that is, it has only one cestrus in a sexual season); yet the dog, as is well known, comes on heat and breeds, as a general rule, twice a year. Moreover, it can no longer be affirmed that the procestrus of the lower mammal corresponds simply to the menstrual flow of the human female.

There is a paragraph describing Spemann's work up to 1924 on the process of differentiation of the ovum, but we would have liked some accoun of the more recent advances in experimenta embryology. In view of the great complexit which the study of the sex hormones has attaine as a consequence of recent researches, it may b doubted if the Lillie-Minoura explanation of th 'free-martin' can be held in the simple form i which it was presented.

A word of praise must be added for the excellen illustrations, and the book as a whole may b recommended to medical students and practitioner who desire a clearly written presentation of th principal facts of human embryology. Suc criticisms and suggestions as are made above hav been put forward with a view to further improve ment when the book reaches a fourth edition.

F. H. A. MARSHALL.

Aspects of Higher Mathematics

(1) Leçons sur la théorie des espaces à connexion projective

Par Prof. E. Cartan. Rédigées par Dr. P. Vincensini. (Cahiers scientifiques, Fascicule 17.) Pp. vi + 308. (Paris: Gauthier-Villars, 1937.) 85 francs.

(2) Differential Systems

By Prof. Joseph Miller Thomas. (American Mathematical Society, Colloquium Publications, Vol. 21.) Pp. ix + 118. (New York: American Mathematical Society, 1937.) 2 dollars

(3) Introduction mathématique aux théories quantiques

Par Prof. Gaston Julia. (Cahiers scientifiques. Fascicule 16.) Première partie. Pp. vi + 220. (Paris: Gauthier-Villars, 1936.) 60 francs.

(4) Éléments de géométrie infinitésimale

Par Prof. Gaston Julia. (Cours de la Faculté des Sciences.) Deuxième édition. Pp. vii + 262. (Paris: Gauthier-Villars, 1936.) 60 francs.

(5) Über einige neuere Fortschritte der additiven Zahlentheorie.

Von Edmund Landau. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 35.) Pp. vii + 94. (Cambridge: At the University Press, 1937.) 6*s*. net.

(1) PROF. CARTAN'S work on the theory of spaces with projective connexions is executed in accordance with a plan originally set forth in another work of his on generalized spaces. The present volume is divided into two parts, the first of which serves as an introduction to the second, and presents a survey of the different methods employed in projective differential geometry with emphasis upon those which may b generalized in the theory of spaces with projectiv connexions proper. Prof. Cartan chooses th simplest of problems here; indeed certain of them are chosen only for their instrumentality illustrating the different methods employed. Thu as he says, the first part cannot lay claim to bein in any sense an exhaustive treatise on projectiv differential geometry.

In the second half of the book Prof. Carta passes on to consider spaces with projective co nexions proper, and, as in Riemannian geometr once the general theory is introduced, two kind of problem arise. First, there are the problem which are consequent upon the consideration the properties of these projective spaces them selves and their differentiation from the classic projective space; and secondly, there are tho which arise from the consideration of the properti of the curves and surfaces in such spaces. Pro Cartan does not, in this work, go into the late developments in generalized projective geometr but he includes an extensive bibliography of wor expounding the most modern researches.

(2) In his extremely interesting treatise o differential systems, Prof. Miller Thomas primarily concerned in developing the theory partial differential equations and that of Pfaffia systems in such a way as to show clearly th relations between the two theories. He uses th postulational method as being the most conduci to generality and conciseness, and proceeds take a few existence theorems and construct h theory upon them. He includes a consisten

proof by proving the postulates in particular cases. There is no systematic development of the theory of commutative polynomial rings in this book, but Prof. Thomas develops in detail the theory of the non-commutative ring known as the Grassmann ring from the postulates of Chapter iii, and in Chapters iii and iv he develops the ideas introduced by Grassmann and perfected by Cartan.

The treatment of the algebraic case is entirely the author's own, and an individual feature of the work which he considers most satisfactorily exhibited in the algebraic case, but which is employed throughout, is the admission of inequations on an equal footing with equations. Together with the use of resultants of all orders, he finds that this admission obviates the necessity of making the preliminary linear transformations of the indeterminates in the solution of algebraic systems.

(3) Of Prof. Julia's two volumes, that on the elements of infinitesimal geometry is a fairly straightforward treatise the substance of which originated in a course of lectures on the geometrical applications of analysis. Prof. Julia finds that the method of vectors provides greater simplicity in the establishment of generality in results. But, in particular problems he thinks that the utilization of Cartesian co-ordinates or some other canonical system of reference which is appropriate to the geometrical nature of the problem under examination, effects a simplification in analysis. A combined use of the geometrical and analytical methods is what distinguishes Prof. Julia's treatise from others of its kind. This second edition contains many additions and a few modifications of detail, all introduced in order to give greater precision and exactitude to the exposition.

(4) Prof. Julia's other work is the first 'fascicule' of a series which is to constitute a mathematical introduction to quantitative theories. In this introductory part of the work Prof. Julia investigates the properties of vector spaces of n dimensions and their linear transformations. Geometrically, a theory of linear operators is obtained which is translated analytically by a theory of matrices. The choice of co-ordinates appropriate for obtaining the simplest matrix of a given operator leads naturally to the reduction of matrices and to the study of the spectrum; in affine geometry the reductions of Jordan are obtained, and in metric geometry the reductions of Schur. This work is once more the result of the combination of analytical and geometrical methods.

(5) In 1935 Prof. Landau delivered the Rouse Ball Lecture in the University of Cambridge under the title "Solved and Unsolved Problems in the Additive Theory of Numbers". The progress which has been made since that date in the solution of some of the problems described by him, forms the subject of this little volume. The substance of three further lectures on "The Class-Number of Binary Quadratic Fields", in which Prof. Landau produced a full proof of Siegel's very important theorem on the class number of the quadratic forms of negative discriminants, is also included here. For the understanding of this summary of progress made, a knowledge of the elements of the classical theory of numbers excluding the theory of prime numbers, is sufficient. Prof. Landau is so well known an authority in this branch of mathematical theory that it is superfluous to say that any utterance of his is of great importance.

A. v. Z.

East Africa

Mountains of the Moon:
an Expedition to the Equatorial Mountains of Africa. By Patrick M. Synge. Pp. xxiv + 221 + 93 plates. (London: Lindsay Drummond, Ltd., 1937.) 15*s*. net.

"THE 1934–1935 British Museum Expedition to East Africa was organized for the purpose of studying the flora and fauna of the equatorial mountains in relation to their peculiar environment." This, the opening paragraph in Mr. Synge's book, succinctly describes the subject about which it is written, one not perhaps new, but fully deserving the attention it receives at the author's hands.

Ruwenzori, with its gigantic lobelias and senecios and the other abnormalities distinctive of its extraordinary flora, was the main objective, but Mts. Elgon and Kenya, the Aberdares and several of the Birunga volcanoes were also visited, and although these are better known than Ruwenzori, the author contrives to present the botanical wonders that he saw and the events of the journeys to find them with a pleasing freshness.

The latter part of the book is devoted to a carefully recorded impression of Uganda—past, present and future—from the political and social points of view. This was Mr. Synge's first visit, but his remarks are well worth careful reading. He deals comprehensively with the subject. Greatly interested in the rise of European education in Africa, he concludes that the mental capacity of

the boys he saw at work, Baganda at Budo and Makerere, is equal to that of the average of European peoples, or the difference is extremely slight. Certainly he feels hopeful of the results; hints at possibilities of improvement, is sceptical of the wisdom of studying Coleridge, of questions on electric lifts and trams, thinks that the English language will eventually oust Swahili as the *lingua franca* of the country, speculates whether the art of Epstein would not appeal more to the native mind than that of Raphael, and is convinced that "Territory can only justifiably pass from one mandatory power to another by a plebiscite of its population."

Appendixes deal first with the legends relating to the sources of the Nile and the Mountains of the Moon, and secondly, with the possibility of the acclimatization in Britain of some of the African mountain plants the author saw.

The illustrations are varied and striking: partly taken from oil paintings and drawings by Stuart Somerville, two in colour; and partly from photographs taken by various members of the expedition. They are by no means the least noteworthy part of the work. Two maps and an index are provided. One slip may be mentioned: the duiker is an antelope, not a deer.

J. P.

Oyster and other Fisheries of Great Britain

(1) Oyster Biology and Oyster Culture:
being the Buckland Lectures for 1935. By Prof. J. H. Orton. Pp. 211. (London: Edward Arnold and Co., 1937.) 5*s*. net.

(2) The Nation's Sea-Fish Supply:
being the Buckland Lectures for 1936. By E. Ford. Pp. 112 + 4 plates. (London: Edward Arnold and Co., 1937.) 3*s*. 6*d*. net.

(1) THE earlier course of Buckland Lectures is devoted to the oyster, a full investigation of which was subsidized for some years, commencing in 1919, by the Empire Marketing Board acting through the Ministry of Agriculture and Fisheries. There was at that time an immense mortality amongst the oysters of the east coast of England, and it was suggested, rather hysterically, that this was due to the dumping of trinitrotoluene in that region—an obvious impossibility. The real cause has never been explained, but the researches of Prof. J. H. Orton and the information obtained by him and here presented will save a second such waste of public money.

Of this presentation we can scarcely write too highly both as to its form and substance—the complete life-history of the 'Native' and an excellent account of its culture. This oyster is shown to be protogynous, changing its sex to the male immediately after spawning and again evicting its gametes. Then, many of the oysters in winter become female and afterwards again revert to male—four changes of sex in thirteen months. Spawning takes place on the beds when the temperature of the water rises to about 60° F., but the causes of good and bad spatting years is still unknown.

(2) In the second course of lectures, Mr. Ford examines our fish supply, stimulated thereto by the profound change effected in the industry by the Sea-Fishing Act of 1933, followed up by the formation of a Herring Industry Board of Control in 1935, probably the prototype of a Whitefish Board in 1938. Previous to this, British vessels were subject to little or no regulation either as to catching or marketing, but few will be prepared to contest the necessity for this somewhat socialistic measure.

To understand the matter it is essential to appreciate the change that has come over Great Britain in recent years, the greatly increased provision of meats, fruit and vegetables at standard prices and so put up that they can be served without further preparation, each purchase 100 per cent nutritive. At present, at least half the fresh fish sold is from the counters of the fish friers, fish otherwise being largely a luxury product, as can be seen from the fact that it has little or no interest to co-operative societies. In consequence, the industry, while formerly thinking largely in terms of fish-bulk, now has to deal mainly with the demand for species in economic quantities. Before the Great War there was a question of overfishing of grounds induced partially by thoughts of lessened catches, these met later by geographical boundaries being extended and improved methods of fishing.

Still the question of a holocaust of undersized fish is with us, but the researches of the western nations of Europe in the International Council for the Exploration of the Sea, reconstituted in 1919, now make possible the free acceptance of international regulations, such as sizes of mesh of nets and size limits for each marketable fish. The author is an acknowledged expert whose discussion is always both of value and of importance—and above all he bids us to remember that "fish are livestock which need to be exploited with reasonable care and caution".

Gmelins Handbuch der anorganischen Chemie
Achte völlig neu bearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft.

(1) System-Nummer 36 : Gallium. Pp. xviii + iv + 100. 13.87 gold marks.

(2) System-Nummer 37 : Indium. Pp. xviii + iv + 116. 15·75 gold marks.

(3) System-Nummer 23 : Ammonium. Lief. 2 : Verbindungen bis Ammonium und Kalium, Hydrazonium, Hydroxylammonium. Pp. 243–602. 44.25 gold marks.

(4) System-Nummer 59 : Eisen. Teil A, Lief. 8 : Fe–C (Fortsetzung) ; mechanische und thermische Eigenschaften ; Systeme Fe–C–H bis Fe–Be–K. Pp. 1635–1818. 24.37 gold marks.

(5) System-Nummer 59 : Eisen. Teil D : Magnetische und elektrische Eigenschaften der legierten Werkstoffe. Pp. xlviii + 466. 57.75 gold marks.
(Berlin : Verlag Chemie, G.m.b.H., 1936.)

(1 AND 2) The metal gallium was rather neglected until about 1915, when advantage was taken of the long interval between its low melting point and high boiling point to use it either alone or alloyed with five per cent of indium for filling high-temperature thermometers. Gallium has also been used effectively by Bates for alloying with cadmium in the construction of an enclosed cadmium arc lamp. The alloy has a much lower melting point than pure cadmium and does not adhere to the silica on cooling, so that the risk of fracture is greatly diminished. Moreover, the arc spectrum of the cadmium is scarcely affected by the presence of gallium. Indium has as yet found very little commercial application. It was formerly obtained exclusively from zinc-blende, but is now a by-product in the cadmium residues of the lithopone industry. Recently, Brewer and Miss Baker have discovered unusually large amounts of it in cylindrite, a lead-tin-antimony sulphide from Bolivia, and also as a general impurity in tin.

(3) The volume on ammonium contains an account of the salts of the radicals ammonium, hydrazonium and hydroxylammonium. Of the numerous ammonium polysulphides mentioned in the literature, only one, the pentasulphide, is definitely known. The two amino-groups in hydrazine are unequally basic since only one series of salts is stable, except in the case of the halogen hydracids. The stability of the hydroxylammonium salts towards acids, alkalis and oxidizing and reducing agents is set forth.

(4 and 5) Section 8 of Part *A* of the volume on iron deals with the mechanical and thermal properties of the metal and with heterogeneous equilibria between iron and the elements oxygen, nitrogen, sulphur, silicon, phosphorus, arsenic, antimony and the alkali metals. Part *D* gives a complete account of the magnetic and electrical properties of iron alloyed with numerous elements, other than carbon, these having been separately dealt with previously. The usefulness of this part is greatly enhanced by the inclusion of more than three hundred phase rule diagrams.

Elektronentheorie der Metalle
Von Dr. Herbert Fröhlich. (Struktur und Eigenschaften der Materie : eine Monographiensammlung, herausgegeben von F. Hund und H. Mark, Band 18.) Pp. vii + 386. (Berlin : Julius Springer, 1936.) 28.80 gold marks.

THE electron theory of metals is now so far developed that it can provide adequate explanations of a very large number of the experimental facts concerning the electrical, magnetic and thermal properties of normal metals, and can help us considerably in our understanding of the behaviour of abnormal ones. It is therefore essential for a physicist to have at hand an authoritative and up-to-date survey of the subject. Dr. Fröhlich provides such a survey, starting with a discussion of the fundamental principles of wave mechanics and leading on to a discussion of problems in the emission of electrons, photo-electricity, optical and magnetic properties, the latter being set forth with pleasing clarity. Then follows a sound treatment of electrical conduction and allied phenomena, succeeded by articles on semi-conductors and on the metallic state in general. The last two chapters, which give an account of ferromagnetism and a systematic examination of the properties of individual metals, are well worth reading.

Fundamentals of Vacuum Tubes
By Prof. Austin V. Eastman. Pp. xv + 438. (New York and London : McGraw-Hill Book Co., Inc., 1937.) 24*s*.

THERE seems no limit to the number of large text-books recently devoted to the operation of practical thermionic devices. The present one aims at combining theory and practice for senior engineering students, not attempting to appeal to the specialist. It assumes a working knowledge of the simple calculus, but emphasizes practical ends in developing the fundamental theoretical aspects. Although thermionic tubes find most varied use in radio transmission circuits, these are not allowed to swamp the increasing importance of industrial applications. Gas tubes and photo-electric devices are naturally included in the general discussion. Both the method of comprehensive treatment and clarity of expression are to be commended. L. E. C. H.

Biology and the New Physics:
a Plea for a Consistent Philosophy of Life. By C. J. Bond. Pp. 67. (London : H. K. Lewis and Co., Ltd., 1936.) Paper covers, 1*s*. 6*d*. net ; cloth, 2*s*. 6*d*. net.

THE rapid changes in the theory and practice of science call more and more for a synthetic adjustment of the complete universe of knowledge. However difficult this task is, one should welcome any genuine attempts towards its completion, as each one of them may open new perspectives which may serve a wider and more comprehensive synthesis. Mr. Bond's forceful and brief plea for a consistent philosophy of life is most interesting from this point of view, and should be read with profit by all those who place values in the forefront of their speculations.
T. G.

The Grain-like Structure of Solids*

By Sir William Bragg, O.M., K.B.E., P.R.S.

A CURSORY glance over the research work described in the scientific publications of to-day shows that remarkable interest is concentrated on magnitudes which are too small to be examined in detail under the microscope and too large to be studied conveniently by X-ray methods. Such magnitudes are to be found in all lines of research, medical, industrial, and purely scientific. Their behaviour presents numerous problems of great interest, and also of considerable difficulty. Solutions are of pressing importance, because the want of knowledge is in all cases a hindrance to progress. When in the course of our work we arrive at these magnitudes we realize that we are facing a key position.

The microscope makes it possible to detect objects as small as a few hundred angströms in diameter, but it is far from revealing the details of objects so small as this. There are other optical methods of detecting such magnitudes. Thus Langmuir has recently shown how the polarization effects of films no more than a few dozen angströms thick can be made visible: but again this method does not supply a means of examining detail.

The X-rays in a sense go too far. Their wavelengths are such that the crystalline arrangement of atoms and molecules can be measured with very great accuracy, but their field of view is too narrow to take in the details of larger structures. Thus there is a gap in the means of inquiry, and it is remarkable how consistently the particular deficiency has inconvenient results.

Magnitudes of this order occur, for example, in the metallurgical field. Their importance is more obvious now that the structures of metals and their alloys are better known. The X-ray methods determine with accuracy the details of the crystal structure of iron and its alloys, but such information is insufficient for a prediction of the behaviour of a specimen of steel. As Smekal has observed, there are certain properties which are clearly connected with structure; and are 'insensitive' to any treatments to which the steel has been submitted in its previous history. But there are other properties, to be described as 'sensitive', which can be modified profoundly by treatment, such as tensile strength, plasticity and hardness, as well as electrical and magnetic properties, and these are most important qualities in practice. Long ago the microscope showed the metal to be an assemblage of grains; and the conditions of the assemblage are clearly connected with the 'sensitive' properties. But the exact details of the connexion are difficult to investigate because they fall within the region in which direct illumination fails.

Metallurgical theory hovers continually over the idea that a metal or an alloy contains minute groups of atoms, or is even a compound of such groups, which may be called crystallites, since the arrangement of the atoms within each one is perfectly regular. The X-ray diffraction is regular and the lines of a 'powder diagram' are clear and sharp. Thus Gough and Wood in their examination of the fatigue of metals due to the cyclic repetition—sometimes to millions of times—of an imposed stress, found that the visible grain gradually broke up to an extent which in any one experiment depended on the magnitude of the stress. Fracture in any one region occurred when the break up into crystallites was complete. It did not imply the disruption of atom from atom resulting in complete disarray, but merely a separation into minute crystals the magnitudes of which were arranged more or less closely about some average. This was shown by the form of the X-ray photograph. A definite stage had been reached in the break up of the material. The existence of such an average would imply that the dimensions of the crystallite are in some way referable to numerical relations between the form or dimensions of the atoms of the metal: analogous to, but far more complicated than, the formation of the benzene ring of definite form and size from atoms of carbon each of which has tetrahedral qualities.

The discussion as to the specific existence nature and effect of crystallites has been conducted with great eagerness; very much research on the mosaic structure of crystals in general has been undertaken, and several interesting theories have been put forward. At first, theories were suggested which would have provided a super lattice, consisting of a regular arrangement of crystallites, even in the case of a pure metal. But this suggestion could not be maintained, as it evolved a second linear dimension out of a first. Buerger has suggested that the grain-like structure of a metal is due to conditions of growth, various crystalline processes meeting and joining together in irregular

* From the presidential address to the Royal Society, delivered on November 30.

fashion during the formation of the whole mass. This, however, would lead to a casual formation which does not seem to be in accord with metallurgical experiment. G. I. Taylor's ingenious theory of the hardening of a metal by working requires the existence of crystallites of some form. The whole question is still obscure, yet it is extremely important because the properties of metals and alloys depend to a large extent on the grain-like structure which they possess. Whether so-called 'crystallites' are formed under some law governing their size or are merely accidental assemblages, they are a centre of interest in the examination of metallic properties.

Similar conditions prevail in other cases where the behaviour of materials is under consideration. In April of this year the International Association for the Testing of Materials met in London. The work of the conference was closely connected with pure scientific research, depending on results already obtained and suggesting numerous opportunities for the increase of knowledge. It was remarkable that in the case of one material after another the discussion directed attention to the importance of grain-like structure, and showed that the 'grain', if I may extend the word widely from its general use in metallurgy, was the object of attack. Thus in the vast variety of fibrous materials, the fibre corresponds to the metal grain, and its study is quite as interesting and important. In all colloidal problems the condition and properties of the minute particle are fundamental. In materials derived from living organisms, the cell and its parts are the centre of interest; and of course somewhere in the region of which I am speaking are the outposts of life itself. Even in dielectrics and lubricants, the groupings of atoms and molecules determine the general behaviour.

Moreover, a very considerable change in the use of materials for construction has come about in recent years in consequence of the fact that the gradual changes due to time have become really important. The so-called 'creep' of materials is now one of the chief pre-occupations of the engineer. Its new importance is due to two causes. In the first place, the development of machinery has necessitated more perfect fitting, and less allowance for clearance than was at one time the case, as for example in modern turbines and internal combustion engines. In such fine adjustments a creep of one part in a thousand is a very serious matter. In the second place, the working temperatures have been greatly increased, and creep is thereby encouraged. There is no doubt that in any specimen but a perfect crystal slow changes take place continuously. At every moment molecules are being helped over the barriers which have kept them from positions of greater equilibrium. In this way new crystallizations are set up, or older crystallizations extended. Strain may encourage transfer from one position to another. One might almost say that every portion of a solid is a liquid for a certain fraction of its time, and that the atoms in that portion are capable of a movement which is restricted and guided by the stabilizing action of their surroundings.

The laws which govern these movements are very complicated, and detailed knowledge is scanty though badly wanted. Thus, for example, Dr. Bailey, a pioneer in these matters, finds that the addition of 1 per cent chromium to a 0·5 per cent molybdenum steel increases its initial resistance to creep below a certain temperature and lessens it above. It is probable that the addition of chromium atoms locks the grain structure so long as they stay where they are: but heat facilitates their moving, all the more readily because the complicated alloy has the looser structure. Once they have moved, the material would be better without them. But such a rough explanation would be well set aside for a detailed knowledge of the processes involved. Here are very interesting problems of physics and chemistry.

The careful examination of a visible cellulose fibre shows, it is said by some, that it is built up of lesser fibres, fibrillæ or fibrils which again consist of ellipsoidal objects of dimensions roughly 1·5 μ and 1·1 μ. Each such object may contain many millions of cellulose chains, but very little is known of the structure of the contents or of the sheath that encloses them and seems to be the source of their characteristic influence. Chemical analysis and X-ray examination give a satisfactory picture of the cellulose chain-like molecule, and some information also of the details of the molecular assemblages. But information is wanted respecting the larger groups and the fibril formation on which the fibre properties obviously depend. If the fibre belongs to a living organism, change with time may be synonymous with growth. If the fibre is an element of some material in use, it is still subject to change which may seriously affect its quality.

Change may be external or internal. The slow rearrangements of recrystallization or devitrification are due to internal forces: but surface changes due to reactions with surrounding atoms such as corrosion or hydration may also affect behaviour. Naturally such surface changes are the more important the smaller the particle of the substance, as the colloid chemist points out. Thus, for example, it is a much discussed question as to how clay holds the water that is associated with it. The X-ray analysis supplies a very reasonable picture of the clay crystal; the positions of the

atoms of oxygen, silicon, aluminium, magnesium, iron and the rest are known with considerable accuracy. But the remarkable properties of clay are dependent on the behaviour of the larger flake-like assemblages of colloidal dimensions, which lie between the direct observation of the X-ray methods and those of the microscope.

In dielectrics the slow changes of time bring about rearrangements, hastened by the electrical tensions to which the material is subjected. The electrical forces look for the weakest point for a break-through, just as a stress discovers the weakest point of a chain or any member of a structure. Changes are therefore important. One would wish that a structure was like the "Deacon's shay", which was so designed that every part was as strong as every other so that when the shay came to its end, it became a heap of dust upon the road. Unfortunately, that is not the case with any material in use: and whatever its structure an equal balancing is apt to be destroyed by changes in its grain-like condition.

Perhaps the structure of the huge protein molecules may suggest a way of closing the gap in our knowledge and our means of inquiry. It is a very striking fact that their magnitudes tend definitely to group themselves about certain values, which, moreover, are simply related to one another. They are not mere groups of atoms thrown together without design. Their definite formation implies obedience to rules which must be in force at the beginning of the assembling, and are in force until an unavoidable result is reached. This would mean, as indeed a vast number of observations already imply, that the junction of carbon atoms is governed by strict geometrical laws of distance and orientation. It has indeed been pointed out by Dr. Wrinch and others that the long chains consisting of two carbons and one nitrogen in regular succession can be formed, under the guidance of the rules mentioned, into space-enclosing sheets presenting an external appearance of linked hexagons, and the number of sizes to which these assemblages can attain is limited. Possibly we have here an example of a form of procedure from the groupings of a few atoms to the larger assemblages of thousands, the process depending on a certain obedience to laws of building which have been shown to hold in the simpler case. We are encouraged to hope that this may be so, by the unexpected strictness and definiteness of the building rules in the cases which fall within the scope of the X-ray methods.

The constitution of the solid body is being examined now as it has never been possible to examine it before. We are not surprised that it is found to possess a grain-like structure, or that this structure is of first-rate importance. It is not only of interest from the purely scientific point of view, but also it turns out to be of fundamental importance to all the constructive work of industry and to all the examinations of living constructions within the domain of biology. In the effort to know its details and to understand their significance a host of interesting scientific inquiries make their appearance, so that industry and science more than ever play into each other's hands. It is certainly to be expected that from these tempting labours there will result much improvement of natural knowledge.

Progress in the Transport and Storage of Foodstuffs

THE work of the Food Investigation Board is carried out in the interests of the general body of consumers in Great Britain and is directed to reducing waste and improving the variety and quality of foodstuffs generally available by the application of scientific knowledge to the problems of storage and transport. The annual report of the Board*, besides describing the Board's activities, includes, in the report of the Director of Food Investigation, a concise statement of the progress of the investigations carried out during the year under review, many of which have not yet reached the stage at which full publication of the results is feasible. The keynote of the Board's activities in 1936 was its co-operation with other bodies interested in similar problems of food preservation in different parts of the world. The British Commonwealth Scientific Conference met during September 1936, and the members visited the various experimental stations maintained by the Board, namely, the Low Temperature Research Station at Cambridge, the Torry Research Station at Aberdeen, and the Ditton Laboratory at East Malling in Kent. The seventh International Congress of Refrigeration was held at The Hague in June 1936 and was attended by several members of the Department of Scientific and Industrial Research. A number of visits abroad were paid by members of the Food Investigation staff: thus

* Report of the Food Investigation Board for the Year 1936: Department of Scientific and Industrial Research. Pp. 235 + v. (London: H.M. Stationery Office, 1937.) 3*s*. 6*d*. net.

Dr. A. J. M. Smith proceeded to South Africa to consult with the authorities there on a number of questions relating to the export of foodstuffs; Dr. R. G. Tomkins went to Palestine to discuss questions relating to the transport and storage of citrus fruits; Dr. E. C. Smith was present at the opening of the new laboratories of the Kältetechnische Institut at Karlsruhe, and finally Dr. F. Kidd, superintendent of the Low Temperature Research Station, proceeded to South Africa to act as chairman of a commission set up by the Government there to inquire into matters connected with the export of deciduous fruits.

A 'refresher' course was held at Cambridge, in co-operation with the National Institute for Research in Dairying, the Fruit Preservation Research Station, Chipping Campden, and the Torry Research Station, and was attended by members of the Services, of research associations and of the scientific and technical staffs of various firms. Members of the Engineering Committee attended meetings of a consultative group, consisting of representatives of the manufacture of refrigerating plant, and of the consultative group which represents the shipping industry, thus having brought to their direct notice the actual problems encountered in commercial practice.

The Board has arranged for the preparation of a report dealing with the application of thermodynamical methods to the equilibrium state in biological systems, including industrial applications of the biological sciences, and also of a report summarizing our present knowledge of the chemistry of the apple.

The Board makes a special reference to its relationship with home agriculture, pointing out that the distinction between production, on one hand, and transport and storage, on the other, is justified on the grounds of expediency alone. It is obvious that where the agricultural product is to be stored or to receive other special treatment, production and research in production must have that end in view. Producers require a specification towards which to work; the preparation of that specification is the task of the Board. Although research has not gone far enough to make such specifications possible yet to any great extent, still it is already possible in some measure to specify, in scientific terms, what is required of the producer in an apple for storage, in a fish for smoking, and in a pig for the manufacture of bacon. Such specifications will increase in scope and accuracy as research progresses.

It is possible to refer here only to a few of the results obtained in the many scientific researches carried out by the members of the Food Investigation staff. Some of those with a probable immediate practical application will be selected. From the results of investigations at the Ditton Laboratory during the past few years, it appears that the pear responds even more favourably than the apple to gas-storage; Conference and William's Bon Chrétien varieties can be stored successfully for several months at 34° F. in atmospheres containing 2·5–10 per cent oxygen and 5–10 per cent carbon dioxide. It appears that the successful achievement of long periods of storage depends to a great extent upon bringing the fruit to gas-storage at a low temperature with the minimum of delay after gathering. After removal from the store the fruit ripens more slowly and therefore allows more time for marketing than fruit that has not been stored in this way. It is hoped that this new knowledge will lead to a considerable increase in home production.

The condition known as 'storeburn' is due to excessive evaporation of water and can be prevented if the foodstuff is suitably wrapped. Aluminium foil covered with waxed paper has been shown to be a suitable wrapping for both frozen lambs' kidneys and Sussex poultry, when stored at − 10° C. The birds were trussed and allowed to cool and set (with the heads down) for 16–20 hours at room temperature before storage; after five months the fowls were thawed and drawn. The guts, including the liver, were found to be firm and perfectly wholesome; the birds were cooked and eaten and found to be indistinguishable from freshly killed chickens.

Last year it was reported that muscular tissue from the carcasses of pigs that had been overheated before slaughter had an abnormally high electrical resistance; it has since been found that hams made from these carcasses showed an unusually high incidence of taint. Farm-killed pigs give low values for electrical resistance and a low incidence of taint. The electrical resistance of factory-killed pigs can be reduced to a certain extent by resting the animals before slaughter. The high electrical resistance is associated with a rise in the ultimate *p*H of the tissue after death—presumably due to loss of glycogen during the exercise taken just before death—and a decrease in the rate of penetration of salt during curing, two factors which predispose to bacterial spoilage.

Other interesting results have been obtained on the retention of fertility in eggs during storage, on the storage of potatoes and broccoli and on the corrosion of the tinplate container used for canned foodstuffs, but for the details of these the original report must be consulted. The extracts already given must suffice to indicate the activities of the Food Investigation staff during the past year.

The Sex-Ratio

AT the recent Nottingham meeting of the British Association, the first morning was devoted by Section D (Zoology) to a symposium on the sex-ratio. This was introduced by Prof. F. A. E. Crew's presidential address, which reviewed the subject in detail and formed an essential part of the discussion as a whole. A number of the facts brought forward by the speakers, and the conclusions drawn from them, merit the attention both of general biologists and of those interested in the various aspects of the population problem.

In man, the secondary sex-ratio, being that which obtains at birth, approaches equality, with a small but definite excess of males. At the present time in England it is approximately 105·6 : 100. There is no doubt that this is derived from a much higher sex-ratio at conception (the primary sex-ratio) by a differential elimination which favours the female. A continuance after birth of this lower male viability reduces the sexes to equality in late adolescence. Afterwards it reverses the ratio, leading to an excess of females which steadily increases in the higher age groups until there are more than twice as many women as men amongst those aged eighty-five years and more.

The effect of this constitutional difference in vigour is expressed in varying degree. Unsuitable conditions, both before and after birth, tend to enhance it, and a favourable environment will partially, but not completely, obscure it. Furthermore, Dr. W. O. Kermack pointed out that it is subject to secular trends which are reflected in the sex-ratio when studied over long periods.

Two fundamental difficulties are encountered in explaining these facts: the lower viability of the male sex, and its excess at conception. The latter condition is especially remarkable, for the simple chromosome mechanism by which the sexes are controlled seems adapted to ensure their initial equality. Prof. Crew rightly stressed that these two problems can only be interpreted by a comparative study of a wide range of organisms.

The differential viability of the sexes is the more easily approachable subject. Now it may seem that the sex-determining mechanism is itself sufficient to account for this phenomenon, as one of the sexes (the heterogametic sex) possesses but a single *X*-chromosome. Its partner is the *Y*-chromosome. This retains a homologous pairing, as well as a non-homologous differential, segment; a feature discussed by Dr. P. C. Koller, who showed that it secures the separation of the sex-determining regions. However, the genes carried in the non-homologous part of *X*, which is often large, are without corresponding factors, or allelomorphs, in *Y*. Thus their action, even when recessive, and therefore disadvantageous, cannot be obscured by normal allelomorphs. These, however, prevent the expression of such recessives in the other, or homogametic, sex; for this lacks the *Y*, being provided with two *X*-chromosomes. Even here they will occasionally operate, but only when present in double dose, and this is a rare event. There is thus a tendency towards lower viability in the heterogametic sex, which is the male in the human species and other mammals. However, it was shown during the present discussion that this attractive theory is in fact inadequate to explain the departure of the sex-ratio in favour of the female.

This is a conclusion of considerable importance. It was reached by a consideration of the sex-ratio in those forms in which the chromosome mechanism of sex-determination is reversed, the female being the heterogametic sex. If the theory just outlined were an adequate explanation of the facts it seeks to explain, the bias of viability should here favour the male. Two groups of this kind are available for study: the birds and the Lepidoptera. The data on their sex-ratio, supplied respectively by Prof. Crew and Mr. E. B. Ford, indicated that, contrary to expectation, the male still remains the less hardy in these forms.

We must therefore regard the lower viability of this sex rather as an outcome of maleness itself than as a result of a particular chromosome constitution. It has been demonstrated that the metabolic rate of the male, whether heterogametic or homogametic, is higher than in the female, and it appears to be in this greater expenditure that the explanation of his lower viability is to be found. The chromosome mechanism must indeed play a part, in the way outlined, but it seems to be a subsidiary one. It was also suggested that agents such as calcium salts may play a part in determining the sex-ratio, through a differential elimination of the sexes. Further information appears to be necessary before this view can be sustained.

Prof. Crew directed attention to the circumstance that, at least in man, the period when the falling sex-ratio brings about transient equality is that of early sexual maturity. It appears, then, that the various factors controlling the sex-ratio are adjusted by selection to procure an equal number of males and females at the time when, in a primitive

society, reproduction is affected. Dr. J. R. Baker and Mr. A. J. Marshall maintained that the sex-ratio is non-adaptive, a conclusion reached by their studies in the New Hebrides, for their figures indicated an excess of males in most of the species examined there. The sex-ratio of the nestling birds, however, approached equality, and we may perhaps question if the subsequent disparity is not to be accounted for, at least in part, by sexual differences in habit among the adults.

Prof. Crew pointed out that the high sex-ratio at conception may be explained by the selection of genes tending to produce an excess of *Y*-bearing sperms, and that such are, in fact, known to exist. Clearly selection would favour a primary sex-ratio high enough to counterbalance, as far as requisite, the lower viability of the male. As explained by Dr. A. Walton, the ease with which the sperms can be subjected to experimental treatment, together with the different physiology of the *X*- and *Y*-bearing types, give ground for hope that means may be found for separating them. The artificial control of sex would thus become possible.

Obituary Notices

The Right Hon. Sir Herbert Maxwell, Bt., K.T., F.R.S.

SIR HERBERT EUSTACE MAXWELL, Bt., of Monreith, died at his home in Wigtownshire on October 30 at the age of ninety-two years. Notwithstanding his great age, and the predecease of nearly all his contemporaries, he retained to the end a mind and spirit refreshingly youthful. His energy, too, was surprising, and, irrespective of weather, he continued to pay his regular fortnightly visits to Edinburgh, leaving his home at an early hour of the morning, to attend a business meeting.

Neither at Eton nor at Oxford did Maxwell distinguish himself; in fact at neither public school nor university did he complete the normal course, yet notwithstanding his lack of application in his earlier years, a lapse which afterwards he bitterly regretted, such was his natural ability and concentration that he lived to be one of the most brilliant Scotsmen of his age and generation.

On leaving Oxford, Maxwell studied for a time at South Kensington with the intention of taking up painting as a profession, but this aim he relinquished when he married and settled down in the country. To the end of his days, however, he continued to use his talent for painting, and has left behind him a large collection of flower studies, executed with remarkable fidelity, charm and skill. Specimens of his work were exhibited at the Royal Horticultural shows in London and elsewhere in recent years.

In 1880 Sir Herbert was returned to Parliament for his native county of Wigtown, and thereafter he continued as its representative until 1906. He accepted the office of Junior Lord of the Treasury in Lord Salisbury's administration of 1886, and at the same time he was appointed assistant Scottish Whip, a post which he continued to occupy for the nine succeeding years. Though eager for promotion to Cabinet rank, fortune did not favour him, and this he attributed to the fact that his duties as a Junior Lord of the Treasury deprived him of the opportunities of taking any part in debate. Though he was offered various appointments to Colonial governorships when in the House, he declined them. Not only was he one of the most popular men, but also he had the reputation of being the best dressed man in the House of Commons.

It was not until he was a man of forty that Sir Herbert turned his attention to writing, but from that date onwards anything he wrote readily found a publisher, and his output was exceptional. Works on history, biography, philology, natural history came from his pen, and he will long be remembered by the brilliant series of essays, "Memories of the Months", dealing with every aspect of country life throughout the year. The personality of the author is vividly revealed in the pages of these essays. His keen powers of observation, his sensibility, his knowledge of natural history, his ideals of sportsmanship, his scholarship and his love of the country and the country folk fill the pages. So popular are these essays, and so perennial their interest, that quite recently a fresh issue was made, nearly twenty years after their first publication.

His distinction as a horticulturist was recognized by the Royal Horticultural Society when in 1917 it conferred on him the honour of V.M.H. Besides being the author of "Scottish Gardens", "Trees" and "Flowers", he was a frequent contributor to horticultural periodicals. A singular honour was his election as a fellow of the Royal Society under Statute 12, "in the interests of advancement of natural knowledge".

Archæology appealed to Sir Herbert's mind—the desire to penetrate into the history of his native land behind the written record. The draining of the Loch of Dowalton on the Monreith estate when he was still a comparatively young man and the exposure there of a group of lake dwellings afforded him an opportunity. These and other crannogs were excavated with a party of friends, and were the first structures of their kind to be explored systematically in Britain. A notable collection of relics was recovered which Sir Herbert Maxwell presented to the National Museum of Antiquities of Scotland. At a later date, a valuable collection of relics brought

together by himself was also presented to the same Museum.

As a fellow of the Society of Antiquaries of Scotland, Sir Herbert always took an interest in its proceedings, and in 1901 he was elected president of the Society, a post he occupied until 1913. He was on two occasions, in 1893 and 1911, Rhind lecturer in archæology. When in 1885 an Archæological Society was founded to publish accounts of the archæological and antiquarian remains in the counties of Ayrshire and Wigtown, Sir Herbert was one of the vice-presidents, and for a number of years took up the duties of an honorary secretary. His contributions included an article on the heraldry of Galloway, illustrated with coloured plates prepared by himself.

With these tastes, it was but natural that Sir Herbert should be offered the chairmanship of the Royal Commission on Ancient and Historical Monuments (Scotland) when it was appointed in 1908, an offer which he gladly accepted. For twenty-seven years he presided over the Commission until to the great regret of his colleagues, on the plea 'that it was better to anticipate the failure of his faculties than to outlive it', he resigned. In his parliamentary days he had presided over other Royal Commissions, including that on tuberculosis in 1897. When the Scottish National Library was finally established, Sir Herbert Maxwell, though then eighty years of age, was chosen by the Trustees to be their first chairman. He was appointed lord lieutenant of his county in 1903, and in 1933 he was created a knight of the Order of the Thistle, an honour rarely bestowed on a commoner, and one which gave delight to himself and to a large circle of his fellow countrymen.

It may truly be said that few men by their passing leave such a pleasant memory behind to such a large number of friends as has Sir Herbert Maxwell. He was laid to rest at the little kirk of Kirkmaiden beside the sea, where many of his forebears for three hundred years had preceded him. The procession that followed him to his grave is said to have extended for two miles along the country road, notwithstanding the remoteness of the spot, an indication of the esteem in which he was held.

A. O. C.

Dr. Adolf Lehmann

ADOLF LEHMANN was born in 1863 at Orillia, Ontario, of German parentage. He died in Kingston, Ontario, on September 27, after eight years of invalidism, brought on by a paralytic seizure. His unfailing courage and optimism did not leave him during those long years of inactivity and helplessness.

Dr. Lehmann studied agricultural chemistry at the Ontario Agricultural College, and organic chemistry under Wislicenus at Leipzig, where he worked on the reduction of dibenzene diphenylbutadiene to tetraphenylbenzene. He acted as assistant chemist at the Dominion Experimental Farm at Ottawa, and as chemist at the Agricultural Experimental Station in New Orleans. In 1898 he went to India to establis a State department of agriculture for the Governme of Mysore. His training at Ottawa and New Orlea fitted him for his work at Mysore. His nine annu reports to the Government of the State are fille with data on the growth of such crops as sugar-can rice, coffee and sweet potatoes under different co ditions of rainfall, amounts of fertilizers, time planting and harvesting. Analyses of soils, fertilize feeds and foods were carried out in great number During this time he developed a method for th estimation of phosphorus in plant and anim material.

On returning to Canada, after a short period as teacher of organic chemistry at Queen's Universit Dr. Lehmann was called to the new University Alberta to organize the Department of Chemistr Here he spent his most fruitful years, not only professor of chemistry, but also, in the earlier year as provincial analyst and professor of soils. In th new province he stimulated an interest in scientif agriculture by his work in the laboratory and in h contacts with all classes and conditions of peopl He made the earliest systematic examinations of th bitumen in the bituminous sand deposits of th Athabaska River, which have intrigued men science and enterpreneurs for many years. He sa his department grow from a mere handful of studen to more than 700 in the eighteen years of his work Alberta.

Dr. Lehmann was an active and valued member many scientific societies. Even after soil chemist came into other hands in the development of th University of Alberta, he maintained his interest agricultural science and agricultural organization But his great service was done in the classroom an with his students and colleagues, whom he inspire by his scrupulous exactness and his devotion to h work. The present writer, who knew him as a co league, is indebted to a fellow worker with D Lehmann, Dr. O. J. Walker, for much of the abo details. In Dr. Walker's words : "His many graduat speak for the interest he gave them in science, f they are scattered over the North American continen engaged in teaching and in industry. They we always able to feel that their mentor was interest in their activities, and shared in their successes an failures."

WE regret to announce the following deaths :

Dr. G. A. Boulenger, F.R.S., formerly in charg of the Reptile Collections in the Department Zoology, British Museum (Natural History), November 23, aged seventy-nine years.

Prof. Edward L. Nichols, emeritus professor physics in Cornell University, on November 10, ag eighty-three years.

Mr. C. G. Rogers, C.I.E., formerly chief conservat of forests, Burma, on November 18.

Sir Seymour Tritton, K.B.E., past president of t Institute of Locomotive Engineers, also known f his work in connexion with the British Standar Institution, on November 19, aged seventy-five yea

News and Views

Pilgrim Trust Lecture

TIME and again in these columns it has been urged that the international character of science gives its disciples a special mission at the present time in promoting co-operation among the nations. Indirectly, by correspondence with other workers and by international congresses, something has been accomplished; individuals of different nationalities have been brought together and have learned to appreciate something of each other's points of view and mode of approach to a problem. There is, however, plenty of scope for further movement on these lines, and we therefore welcome the announcement in the annual report of the Council of the Royal Society that the Pilgrim Trust has agreed to provide 250 guineas a year for six years for an annual lecture, to be arranged jointly by the Royal Society and the U.S. National Academy of Sciences and to be given alternately in London and Washington (p. 979). The fact that a body of the character of the Pilgrim Trust has supported the proposal, and that it was put forward jointly by the two leading scientific bodies of Great Britain and the United States, is of great significance. The foundation of the lecture, coming almost simultaneously with the announcement that negotiations of an economic character are to take place between the two countries, should make even stronger the link binding together the English-speaking peoples of the world in peaceful progress. The first lecture will be given next summer, in London, by an American man of science.

SIR WILLIAM BRAGG made special reference to the Pilgrim Trust Lecture in his presidential address. As he rightly pointed out, these lectures, from the circumstances of their origin, might well be used to mark the progress of science rather than to honour particular scientific workers. They should not be summaries of past work, however important that may be, for other provision already exists for its recognition; rather they should serve to transmit new ideas which have already begun to bear fruit and give promise of wide expansion in the future. By means of the lectures, it will be possible to convey the personal character in the work of a man who opens up a new field of advance, which can only be done adequately by the man himself. Sir William also expressed the hope that the universal wish to promote peaceful relations between the nations of the world may induce other bodies to establish similar lectures. The regular exchange of men able to transmit to other nations the new knowledge which is being gained should indeed be firmly established and recognized by learned academies and by States as a substantial means of promoting progress in all fields of knowledge, as well as the conditions of peace necessary to secure it.

A Lost Neanderthal Tooth

AMONG the recent accessions to the British Museum (Natural History), South Kensington, some of which are referred to later in these columns, is a molar tooth of Neanderthal man. This tooth has been identified as a 'milk tooth', which originally formed part of a series of palæontological specimens collected in Gibraltar by Capt. F. Brome, governor of the military prison, and forwarded by him to England in 1865. The tooth was mentioned by Mr. George Busk in 1868, after which date it disappeared and had been lost to science for nearly seventy years. Its recognition is due to Dr. A. Tindell Hopwood of the British Museum, who furnishes the following particulars of the identification. An unworn human tooth, fastened to a small square of blue paper and contained in a cardboard pill-box without lid, was received some months ago in the Department of Geology with various specimens from the Royal Dental Hospital. This, with some others, was passed to Dr. Hopwood for examination. His interest was aroused by a small printed label gummed to the paper and identical with labels on specimens from Gibraltar already in the Museum. This suggested that the tooth might be the one reputed to have been found by Brome, and examination disclosed the correct date (24.2.65) written in ink in the lower left-hand corner and on the back of the blue paper "$\overline{1}$m under six years"—evidently the ground for constant reference to a milk tooth, and leaving little doubt as to the origin of the specimen. Capt. Brome's investigations in the Genista cave, from which the specimens came, lasted over a period of years in the 'sixties of the last century. The cave, which was named "Genista" in his honour, was discovered when the prison, of which he was governor, was being enlarged, and in the course of digging a new tank, fissures were observed in the limestone.

Gibraltar Man

THE gift of this historic tooth of Neanderthal type from Gibraltar to the British Museum (Natural History) serves to recall the fact that it is only by little more than an accident that a certain primitive type of *Homo* is now known specifically as "Neanderthal" and not as *Calpicus*, from Calpé, an ancient name for Gibraltar; for the first known example of Neanderthal man came to light in a rock-shelter, or the remains of a cave, in Forbes' Quarry, Gibraltar, in 1848, nine years before the discovery of the type skull in the valley of the Neander in Germany. The history of the discovery was found by Col. E. R.

Kenyon in 1910 in the minutes of the long defunct Gibraltar Scientific Society. The skull was presented to the Society by the finder, Lieut. Flint, its secretary; but its remarkable and peculiar character was not appreciated until long after, when in 1862 it was sent to England by Capt. F. Brome, governor of the military prison, with a quantity of palæontological material which he had obtained from the Genista cave, where he carried on investigations for some years. It was then examined by Mr. George Busk and Dr. G. H. Falconer, who immediately recognized its importance as a new and distinct type of *Homo*, the latter wishing to give it, as already mentioned, specific rank in classification. The skull has since been the subject of study by almost every anthropologist of note from Huxley to Keith; and although it differs from the type in certain respects, and its age is not precisely determinable, all are agreed that it is a pleistocene skull belonging to the Neanderthal group. While some would regard the differences from the type as due to its sex (female) others hold that they are marks of an early and primitive character, such as have since been found in the Neanderthaloid skulls from Palestine. A similar skull, but of a child of five years of age, was found in 1926 by Miss D. Garrod in a recently discovered cave; and in the same stratum were flint implements of late Mousterian type. The original Gibraltar skull was presented by Mr. G. Busk to the museum of the Royal College of Surgeons of England, where it is now exhibited.

Prof. P. M. S. Blackett, F.R.S.

PROF. P. M. S. BLACKETT, of Birkbeck College, University of London, who succeeds Prof. W. L. Bragg in the Langworthy chair of physics at Manchester, is engaged mainly in work on cosmic rays, and it is fair to say that nearly all the cosmic ray research in Great Britain has been done with his advice or under his direction. Blackett's first important scientific work was the development of the Wilson cloud chamber into an automatic instrument for the study of rare events such as close nuclear collisions and nuclear disintegrations. He investigated the energy and momentum relations in these processes in the Cavendish Laboratory between 1922 and 1932. Following the discovery, by Skobelzyn, of tracks ascribed to cosmic ray particles, Blackett devised the counter-controlled cloud chamber in which the expansion is initiated by the passage of the cosmic particle and the track is formed and photographed before the ions are diffused. The counter controlled chamber placed in a magnetic field allows the measurement of the energy of the particles, and Prof. Blackett has been occupied with this method of investigating the cosmic rays since 1933, using latterly the large magnet erected for the purpose for the Royal Society. He had established a school of cosmic ray research at Birkbeck College, and several of his collaborators will continue their work at Manchester. In addition to this main interest, Prof. Blackett has worked on the production and properties of positive electrons and on the specific heats of gases.

Improvements in Television Equipment

IT is natural to expect that the continuous operation of a public television broadcasting service in Great Britain will be accompanied by steady improvement in technique and equipment. An outstanding advance in the latter has recently been achieved by the production of the Super-Emitron camera in the laboratories of the Marconi-E.M.I. Television Co., Ltd. This new camera has already reached the stage of practical application, since it was used recently by the B.B.C. in television broadcasts of the Lord Mayor's Show and of the Cenotaph ceremony on November 11. A brief technical description of the new camera, published in the *Wireless World* of November 18, shows that the major improvement depends upon the separation of the photo-electric screen and the mosaic screen which is scanned by the cathode ray beam. As a result of this separation, the photo-electric surface, upon which the visual image of the scene being transmitted is focused, may be made transparent. In this way, certain limitations placed upon the optical projection system of the present Emitron cameras have been removed; lenses of shorter focal length and wider angle may be used, and even telephoto lenses when required. Further, the separate mosaic screen may be made from substances having high secondary emission, and consequently considerable electron multiplication may be obtained in the tube itself, thus giving additional overall sensitivity. With the new camera, therefore, less illumination of the subject is necessary for the attainment of a good picture if the normal aperture lens system is retained. This is a valuable feature in outdoor broadcasts on dull days, or when using a telephoto lens for the reproduction of distant scenes. If the normal illumination is retained, however, as in studio work, the aperture of the lens can be reduced with a consequent gain in depth of focus.

ALTHOUGH in the United States of America regular television broadcasts have not yet commenced, a considerable amount of research is in progress in the development of television technique and equipment. An additional stage towards the inauguration of a commercial service has been achieved recently by the installation of a high-frequency coaxial cable between New York and Philadelphia, a distance of ninety miles, by the American Telephone and Telegraph Coy. A note from Science Service dated November 10 describes a demonstration in which 240-line television images were transmitted over this cable, which is designed for operation at 1,000 kilocycles per second. Starting in New York, the signals pass through amplifiers about every ten miles. The power for these amplifiers is transmitted through the cable along with the signals, thus making the system independent of any local power source. Special equipment has been designed to prevent the distortion that would otherwise result from the varying velocity of the different signal frequencies along the cable. In the demonstration described, the image reproduced on the cathode ray tube receiver was about eight inches square, and news reels and animated scenes were transmitted over the cable with no important loss of detail

Marconi and Radio Communication

AT a meeting of the Royal Society of Arts on November 10, Sir Ambrose Fleming presented a paper entitled "Guglielmo Marconi and the Development of Radio Communication". The object of the meeting was to commemorate the achievements of the Marchese Marconi, whose work on the practical use of electro-magnetic waves has laid the foundations of a great industry, and provided a means of intercommunication of great importance and advantage to the human race. Sir Ambrose took the opportunity of tracing the early history of electric wave telegraphy, starting with the theoretical work of Clerk Maxwell published in 1865. The experimental demonstration of the existence of electromagnetic waves was provided by H. R. Hertz some twenty years later, and rapid progress was afterwards made by the investigations of Sir Oliver Lodge, Admiral Sir Henry Jackson and other workers.

CONTEMPORANEOUSLY, Marconi was experimenting in Italy and, at about twenty years of age, he came to Great Britain and applied for his first British patent in June 1896. Marconi had a special flair for the practical application of the principles established by others and for overcoming the many and various difficulties encountered in this application. Under his guidance and inspiration, wireless communication advanced rapidly with a continuously widening scope. Sir Ambrose Fleming was personally associated with much of this pioneer work, and he has drawn on this experience with advantage, in presenting an accurate and interesting outline of the progress of radio communication during the past forty years. When the paper is published in the *Journal of the Royal Society of Arts*, it will form a useful historical document, which should prove of great value to the large and rapidly extending class of young radio engineers who are only dimly acquainted with the course of events in the early years of this art.

Science and the Unobservable

AT his Friday evening discourse before the Royal Institution on November 26, Prof. H. Dingle discussed "Science and the Unobservable". An outstanding characteristic of modern physics is the application of the principle that only that which is observable is significant. The first example of such application to arouse general discussion was the abandonment by Einstein of the idea of the absolute simultaneity of events at different places, because of the discovery that it was impossible to determine absolutely whether such events were simultaneous or not. This step met with the criticism that since absolute simultaneity in itself was independent of the means available for observing it, it was illegitimate to call the idea meaningless merely because of the limitations of physicists. On the other hand, the followers of Einstein maintained that if the physical world were regarded as including entities or conceptions which were unobservable either directly or indirectly, there was no criterion for distinguishing the real from the unreal.

AN analysis of the process of observation shows that unobservables fall into three classes: (1) the *logically* unobservable, namely, that which cannot be said to be observed without breaking the laws of reason, for example, a round square; (2) the *physically* unobservable, namely, that which cannot be observed because no physical means exists by which the observation could be made, for example, absolute motion; (3) the *practically* unobservable, namely, that which cannot be observed because of lack of technical skill, for example, the far side of the moon. The last two classes, however, cannot be distinguished in practice unless we assume that we know completely all the physically possible means of observation which exist. The practice of physics is to reject the logically and the physically unobservable and to accept the practically unobservable. Hence, since physics distinguishes between the physically and the practically unobservable, it must assume that we know completely all the physical means of observation which exist. From the realist point of view, therefore, we are in the dilemma that we must either assume omniscience in this sense, or else confess that we have no guarantee that what we observe has any importance when compared with the equally real physically unobservable part of the universe. The dilemma disappears if we adopt the idealist doctrine that the physical world is a mental construct formed to give rational meaning to our observations. In that case we reject the physically unobservable because our aim is to construct the world out of observation and not out of fancy, and we do not presume omniscience because we erect no barrier against further observations of any conceivable kind. It follows that modern physics is justifiable only in terms of an idealistic philosophy.

Water Supply and Public Works

A SERIES of papers at the recent Public Works Congress dealt with water supply. The connexion between water supplies and town planning was discussed by Mr. G. H. Thiselton-Dyer, who pointed out that, with few exceptions, sources of water supply are suspect or actually polluted, and that it is doubtful whether even those which are regarded as safe will remain so under the changing conditions of modern life and the scrutiny of the bacteriologist, who can now detect evidence of contamination which was not revealed by older methods of analysis. It was also remarked that it appears to be inexpedient to use the Town and Country Planning Act of 1932 to reserve areas in town planning schemes with the view of preventing pollution, unless the schemes provide for the payment of adequate compensation to the affected landowners. The possibilities of the Lower Greensand as a source of water supply for Greater London was discussed by Mr. H. Dewey, who concludes that no great reliance can be placed upon this source for such a purpose, although use might be made of it as a source of auxiliary supply. The geological section across the London Basin which was included in the paper would have been enhanced in value had the lower limit of the Lower Greensand been shown on it.

RECENT water shortages in various parts of Great Britain lend significance to the paper by Mr. E. G. Bilham on weather and water supplies, in which it is suggested that although the primary source of our water supplies is rainfall, loss of rainfall by evaporation and by seepage is of major importance, and that it is only possible to study this loss by comparing accurate values of rainfall with similar values of run off. So far, this has only been attempted in the case of the Vyrnwy catchment area. Studies of factors affecting the corrosion of water mains and services are given in a paper by Dr. W. H. J. Vernon and Dr. F. Wormwell, the first portion of which deals with methods of protection of the interior of the pipes, a suggested possibility being treatment of the water conveyed with a view to the elimination of corrosion, and a second method being the application of protective coatings. External corrosion by soil and other causes is also dealt with, together with methods of protection in this instance also.

Fifth Annual Exhibition of Kinematography

THE fifth Annual Exhibition of Kinematography arranged by the Royal Photographic Society was held in the Society's house at 35 Russell Square on November 13–27. The Exhibition included examples of the latest types of kinematographic apparatus, a series of interesting exhibits arranged by technical firms within the industry, together with a comprehensive display of still pictures from recent productions. It was opened by Colonel J. T. C. Moore-Brabazon. In his address, Colonel Moore-Brabazon stressed the importance of kinematography in education, research and in the preservation of records, and paid tribute to the progress which has been made, particularly on the mechanical side and in the general design of apparatus. An interesting series of lectures and demonstrations was arranged to run throughout the course of the Exhibition, on technical subjects connected with kinematography, standard and sub-standard.

IT is true to say that this Exhibition succeeded in demonstrating how close is the relationship between the Royal Photographic Society and the kinematograph industry, and how many and great would be the advantages to both of a closer association. In the past a limit has been placed upon the activities of the Royal Photographic Society by the size of the premises at 35 Russell Square. New premises have, however, recently been acquired in which, after reconstruction, there will be three lecture halls, a library, museum, a council room, meeting rooms and a members' lounge, and under these conditions the way will be made easy for further developments. The expense entailed in connexion with the acquisition and reconstruction of the new premises is, of course, very great, and an appeal for funds has lately been launched by the Society. It is hoped that the response will be adequate; science and industry have profited greatly by the advances made in photography, and the premier photographic society in the world deserves well of the community.

The Newcomen Society

AT the annual general meeting of the Newcome Society, held at the Institution of Civil Engineers o November 17, Engineer Captain E. C. Smith wa elected president for 1937–38. In the report of th Council, it was stated that there has been an increas in membership during the year of 149, the tot membership now standing at 576, more than ha the members residing in the United States. Th 300 signed copies of the "Collected Papers of Rhy Jenkins" have nearly all been sold, and Extra Publica tion No. 4, "John Smeaton's Diary of his Journe to the Low Countries 1755", is in the Press. Th financial position of the Society is very satisfactor After the conclusion of the business a paper was rea by Captain F. B. Ellison on "The History of the Ha Railway, 1810–1864". This line, more than 25 mil long, was one of the longest of the pre-steam railway It was built mainly for the conveyance of coal t a district north of Hereford, hitherto served by pac horses. Its terminus was on the Usk at Brecon, t which a canal had recently been made. First surveye in 1810, the proposal for a railway, or rather tran way laid with iron rails, met with immediate sup port, among the contributors to the funds being th Earls of Oxford and Ashburnham, the Duke o Beaufort and Viscount Hereford, who was the chai man of the company. An Act of Parliament for th line was obtained in 1811, and tenders were soo afterwards accepted for 2,800 tons of "Cheltenha tram road plates of strong bodied pig iron to b 50 lbs. per plate" and for 20,000 stone blocks weighin 168 lb. each for sleepers. There were several bridg on the line and one tunnel 600 yards long, this bein constructed by a miner of Newnham, Gloucestershir The tramway continued to serve the district unt the formation of the Hereford, Hay and Brecc Railway, which bought up the line, sold the tra plates and used the stone sleepers in its bridges but recently some of the material has been found i good preservation, and many old documents an plans have been brought to light. These are now bein preserved in Hereford Museum.

University College, London: Extension of Buildings

UNIVERSITY COLLEGE, London, by the offici opening of a further portion of the Foster Cou buildings, has reached another milestone in i development. A previous stage of the Foster Cou scheme was marked by the opening of the ne Department of Zoology by the Chancellor of th University, the Earl of Athlone, in 1933. The chai man of the University Court, Lord Macmilla opened on December 1, the sections of the gener scheme which have recently been completed. The comprise primarily the housing of the Faculty Laws, the Department of Geography, the Juni Laboratory of the Department of Physics, the Ca Gallery of the Department of Archæology, and library centre for the Foster Court departments. B the terms of the endowment of the Yates-Goldsm chair of geology and physical geography, the work physical geography is undertaken in the Departme

of Geology. The special task of the Department of Geography is to promote the study of regional and human geography. Hence, the main feature of the design and equipment of the new department is the emphasis placed on maps and on facilities for their study. The Map Laboratory is a spacious room, with natural lighting on three sides, and artificial lighting provided both by ceiling and by adjustable drawing-bench lamps. Adjoining the laboratory is the map store, where the 3,000 maps which form the existing collection of the Department are conveniently housed. A large lecture room, with epidiascope, a smaller classroom, and a small research room with mapping frames, are all on one floor. The private rooms of the staff and the library are on lower floors. The removal of the Departments of Botany and Geology to the parts of the Foster Court territory which have been allocated to them is still a task of the future.

Pontifical Academy of Sciences

THE first annual report of the reconstituted Pontifical Academy (Annuario della Pontificia Accademia delle Scienze, 1; 1936–37) has been received. The origin of this Academy, in common with that of the Royal National Academy of the Lincei, can be traced back to the foundation in 1603 by Federico Cesi of the ancient Accademia dei Lincei. Founded in Rome with the object of uniting together those interested in the study of the sciences, the Academy adopted the title "of the lynxes" from the supposed sharp-sightedness of those animals. Many of the most famous men of science of the period became members, amongst them Galileo, who received much support from the Academy. Soon after the death of Cesi in 1630, the activities and influence of the Academy declined, but several attempts at revival were made during the next hundred and fifty years. These efforts had no lasting success, however, until about 1800, when there was a greatly increased activity due mainly to the exertions of Abbot Scarpellini, encouraged by Papal support. Shortly after Scarpellini's death the Academy came under the direct control of the Pontiff, and in 1847 received from Pius IX the title of Pontificia Accademia dei Nuovi Lincei.

WITH the capture of Rome in 1870, the new Italian State took over the major part of the Academy's activities, including its library, and formed the Reale Accademia dei Lincei. The Pontifical Academy continued to exist as a separate body, but with greatly decreased influence. In 1936, Pius XI decided to restore the importance of the Academy and reconstituted it under its present title. The Papal Academy of Sciences now consists of seventy academicians, chosen from among the most distinguished men of science, irrespective of nationality and of religious profession. Actually thirty-six of the members are non-Italian and are representative of thirteen nationalities. The British members are Sir Charles Sherrington and Prof. E. T. Whittaker; the late Lord Rutherford was also a member. The Annual, which extends to more than 800 pages, contains a brief survey of the Academy's history, a description of its headquarters, the Villa Pia, in the Vatican, and biographical notes and portraits of each of its seventy members.

Agricultural Education

BOTH the need and the difficulty of instructing the farmer in the practical results of scientific research are well appreciated by many agricultural authorities, but few seem to have been so enterprising as the Bacon Development Board, which has sent to us some specimens of its recent publications. The Board has realized that it is at least as important to 'put over' new information to those concerned with advising and educating the farmer as to approach him directly. The agricultural county organizer, like many other expert technical men, is far too busy to read all the original literature, to select from it and make the necessary summaries, and it must therefore be a great boon to him to receive ready-made such summaries and abstracts as are now provided by the research department of the Bacon Development Board. These abstracts, which are issued yearly by the Board in the form of a report, are exceedingly well done: clear, concise and well selected. There are only about one hundred of them, but they are all to the point and make attractive reading, even to the non-expert. Included in the volume (Report No. 7, Selected Abstracts on Pig Production, Bacon Development Board. Sept., 1937, price 2*s*. 6*d*. post paid) are a thumbnail summary of recent developments, a classified table of contents, and lists of the publications of the Board and of the journals from which the abstracts have been made. Reprints of two outstandingly important scientific papers on pig production have been circulated, as well as brochures on round-worm (*Ascaris lumbricoides*) and the ineconomy of feeding too much protein to pigs. These brochures are not written to 'boost' any product or to subserve any private gain, and therefore they are far more likely to hit the mark than the propaganda efforts of commercial undertakings.

The Norman Lockyer Observatory

IN presenting the annual report and accounts (1936–37) of the Norman Lockyer Observatory, the council thanks the new director (Mr. D. L. Edwards) and his small staff for the work carried out under the difficult conditions consequent upon the death of the late director, Dr. W. J. S. Lockyer. Reference is made to the new sensitometer recently added to the equipment of the Observatory, which will make possible the development of quantitative work at Sidmouth over a wide range of the spectrum. Through the generosity of Sir Robert Mond, Prof. F. I. Blumbach is working at the Observatory as a research associate. The council expresses its view that the best tribute that could be paid to Dr. Lockyer's devoted services would be in the development of the Observatory, which retains so many marks of his attention, care and vision.

Acquisitions of the British Museum (Natural History)

THE Department of Geology has recently acquired, through the generosity of the Medical Committee of the Royal Dental Hospital, a molar tooth of Neanderthal man discovered in Genista Cave, Gibraltar, in 1865 by Capt. F. Brome, governor of the Military Prison. The most interesting recent acquisition in the Department of Minerals is a gilt brass model of a gold nugget from the foot of Croghan, Kinshela, near Arklow in County Wicklow. The original nugget was found in 1795. It was said to have weighed 22 ounces and to have been given to King George III by Abraham Coates in 1796. A model is preserved in Trinity College, Dublin, and a plaster model was presented to the British Museum in 1910. The new model is presented by Lord Seaton. Two fine specimens of hydromuscovite with pyrite and arsenopyrite from the Roman Deep Mine, Ogofau, Carmarthenshire, and specimens of a New British mineral, russellite, a mixed crystal of bismuth and tungstic oxides, from Cornwall, are the most interesting of the other British additions. Natural glasses of problematical origin generally classed as tektites continue to appear in various parts of the world. Through Dr. Spencer, forty-eight specimens of natural glass from Java have been presented by Dr. G. H. R. von Koenigswald. Prof. Suess of Vienna has presented a piece of the so-called kōfelsite—a fused gneiss from the supposed meteorite crater at Kōfels in the Austrian Tyrol. The Department has acquired by purchase some fine groups of cassiterite from Bolivia from Messrs. Gregory and Bottley and has also secured the greater part of the collection of Hugh Septimus Gordon, who specialized in collecting and studying the minerals of the rare earths.

Excessive Marine Growth in Shoreham Harbour

A SHORT time ago a letter appeared in the Press stating that coral was growing in the Southwick basin of Shoreham Harbour, Sussex, and was causing considerable trouble by fouling the bottoms of yachts and small boats lying in this part of the harbour. The Southwick canal, or basin, is locked off from the rest of Shoreham Harbour, its waters being kept at a constant level and free from tidal rise and fall. The sea water in the basin is used to cool the condensers of the Brighton and Hove electric power station, which is situated on its seaward side with coal wharves on the basin. Being of limited area, the water in the basin is appreciably warmed by this means, and is said not to fall below a minimum of about 65° F. At first this growth was thought to be a tropical reef-building coral which had somehow managed to survive the passage from Pacific or West Indian seas on the bottom of a yacht about a year ago, and was able to thrive in the comparatively warm waters of the basin.

THE British Museum (Natural History) was asked to investigate, and Mr. Dilwyn John is at present collecting specimens of the local marine fauna and flora living under the peculiar conditions occurring in the Southwick basin. The 'coral' turned out to be an excessive growth of a polychæte worm, closely resembling *Hydroides norvegica* Gunnerus (Serpulidæ), which lives in tubes of a calcareous nature. It is possibly a species new to science, and is being described by Mr. C. C. A. Monro of the British Museum (Natural History). The growth consists of dense brittle clusters of the white tubes of this worm which grow to approximately 9 cm. long and average 1 mm. in diameter, and are usually cemented one to another. It occurs more frequently around the water-line of floating objects than on piles or the keels of boats, which appears to indicate that light and aeration are favourable to its growth; but the warm water of the Southwick basin seems to be the chief cause of its present excessive development. Perhaps after a full investigation other less conspicuous marine organisms may be found to be behaving in a peculiar manner on account of the interesting conditions occurring in this part of Shoreham Harbour.

Registration and Population Trends

A PAPER read by Dr. R. R. Kuczynski before the Eugenics Society on future trends in population is published in the *Eugenics Review*, 29, No. 2. He points out that in 1837 an Act was passed for registering births, deaths and marriages in England, more than sixty years after such demographic data were recorded in Sweden. His address is mainly devoted to showing the inadequacy of the records as kept in Great Britain compared with those of various other countries, our original birth and death registration forms having remained unaltered up to the present time. The age of the mother at the birth of each child was recorded in Sweden so early as 1774, and in 1839 the Compiler of Abstracts in the General Register Office wrote a letter to the Registrar-General pointing out two grave defects in the records, but nothing has been done. The need is stressed particularly for recording the age of the parents, especially the mother, at the birth of each child, the order of birth and the duration of the marriage, as well as the date of birth. Without such data it is impossible to determine questions of differential fertility and population growth or decline. Various suggestions are made, including that of a special fertility census in December 1938. We should then have within three years a fair knowledge of present fertility trends on which a Government population policy could be formulated with some chance of success.

Conference on Atmospheric Pollution

THIRTY-SIX representatives of local authorities and other organizations co-operating with the Department of Scientific and Industrial Research met on November 29 in the half-yearly conference. Dr. G. M. B. Dobson, chairman of the Atmospheric Pollution Research Committee, presented the report on the progress of the investigations carried out under the Committee. He spoke in particular of the results which are being obtained in the special survey which is in progress in and around the City of Leicester. Two sources of atmospheric pollution which occur in

certain districts were also discussed. It was agreed that a letter be addressed to the Ministry of Health protesting against the continuation of nuisance arising from burning colliery spoilbanks and urging that action be taken to end it. It was also agreed by the representatives to ask the Department of Scientific and Industrial Research to consider and report on the possibility of research being undertaken to develop remedial measures to prevent nuisance caused by zinc oxide fumes in certain stages of the manufacture of brass.

Chronica Botanica

FROM February 1938, *Chronica Botanica* will be issued bi-monthly and no longer as a yearbook. The annual subscription will be reduced from 15 to 7 guilders. The new periodical will continue to give all the essential information which was given in the old yearbook and will include some important new sections. Results of research will be published only in the first two sections. The world list of plant science institutions and societies will appear as an annual supplement. The reorganized *Chronica* will contain short preliminary notes on the results of recent research or announcing new discoveries; discussions, announcements, letters to the Editor; detailed programmes, short reports, decisions, resolutions of international congresses; quotations from recent articles of general and timely interest; personal notes and queries; short reviews of new botany books, etc. The address is P.O. Box 8, Leyden.

Anti-Gas Training and Defence

THE Home Office has published a memorandum summarizing in convenient form the more important information that has already been issued in various circulars of the Air Raid Precautions Department (Air Raid Precautions, Memorandum No. 5. London: H.M. Stationery Office. 4*d*. net). It outlines the suggested organization and arrangements for local anti-gas training. For districts where no gas chamber is available for the training, the Home Office has provided a fleet of 40 motor 'gas vans', by means of which instruction is given in the use of the respirator in an atmosphere of tear gas. In a report, just issued, describing experiments conducted by the Chemical Defence Committee with the object of testing the recommendations made by the Air Raid Precautions Department, it is concluded that sealing a room in the manner suggested, and the use of a gas-mask of the pattern which is being prepared, will give a high standard of protection against aerial gas attack.

Announcements

MR. C. FORSTER COOPER, F.R.S., director of the University Museum of Zoology, Cambridge, and reader in vertebrate zoology in the University, has been appointed director of the British Museum (Natural History) in succession to Dr. C. Tate Regan, F.R.S., who retires on February 2, 1938. Mr. Forster Cooper's zoological work has been concerned mainly with the vertebrates, both recent and fossil.

THE Medal of the Institution of Mining Engineers has been awarded to Dr. Carl Beyling, director of the Experimental Station at Dortmund-Derne, in recognition of his services in the application of scientific knowledge and research to safety and health problems in coal-mining, and to Dr. R. V. Wheeler, professor of fuel technology in the University of Sheffield and director of the Safety in Mines Research Board Experimental Stations at Sheffield and Buxton, in recognition of his services in the application of scientific knowledge and research to problems of safety and health in coal-mining, and of the utilization of coal.

MR. D. P. COSTELLO, of Trinity College, Cambridge, has been awarded the Royal Asiatic Society's Universities Essay Prize for 1936–1937. The subject of his essay was "The Relations of the Greeks with the East". The other essays submitted were of such a high standard that the Council of the Society is also awarding a special second prize to Mr. John Bowman, of the University of Glasgow, for his essay on the alternative subject "Tamerlane".

PROF. A. S. EVE has undertaken the preparation of the authorized life of Lord Rutherford of Nelson, and it is to be published when completed by the Cambridge University Press. It is earnestly requested that any correspondents who have letters, written by Lord Rutherford, which throw light on his life and work, will forward them as soon as possible to Prof. Eve, 26 Willow Road, Hampstead, N.W.3. Original letters will be promptly returned if requested.

APPLICATIONS are invited for the David Anderson-Berry Gold Medal, together with a sum of money amounting to about £100, which will be awarded in July 1938 by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the nature of X-rays in their therapeutical effect on human diseases. A similar award will be made every three years. Further information can be obtained from the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh, 2.

THE following have been elected officers for 1937–38 of the University of Durham Philosophical Society: *President*: The Very Rev. C. A. Alington: *Hon. General Secretary*: Dr. W. A. Clark; *Hon. Treasurer*: Mr. J. W. Bullerwell; *Editor*. Prof. G. W. Todd; *Assistant Editor*: Mr. J. F. Wood; *Hon. Librarian*: Mr. E. Patterson.

THE annual meeting of the Science Masters Association will be held in the Chemistry Department of the Imperial College of Science and Technology on January 4–7. Sir Cyril Ashford will deliver his presidential address entitled "Past and Future Aims of School Science" on January 4. Further information can be obtained from Mr. R. E. Williams, 15 Norham Gardens, Oxford.

Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 975.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Relation between 'Fibrous' and 'Globular' Proteins

ON various occasions in NATURE and elsewhere it has been argued that the elastic fibrous proteins, keratin and myosin, by virtue of the system of intramolecular folds which appears to be their characteristic stereochemical feature, are the linear prototype of the globular proteins, which presumably are constructed to similar principles but in two or three dimensions[1]. Direct experimental support for this view comes from X-ray studies of the denaturation of the globular proteins, which show that the change always results in the appearance of polypeptide chains, which can often be drawn out into artificial fibres analogous to β-keratin or β-myosin[2]. It has also been recognized for some time that feather keratin[3] in particular is to X-rays really both fibrous and globular, and more recently the early observation of long spacings in the keratins has been supplemented by the discovery of even longer spacings in these and other protein fibres[4]. The tobacco mosaic virus[5] is another protein which has properties both fibrous and globular*—and, to cut a long story short, it looks now as if the original apparent distinction between the two types is beginning to disappear. One possible way, based on density and other considerations, of deriving a general scheme directly from keratin[6] amounts actually to building up molecules having essentially the structure deduced from X-ray data for the keratin *crystallites*, and this suggests at once the idea that *the protein fibre crystallites and the tobacco virus units fall into the same category*.

The recent work of Bergmann and Niemann[7] also indicates that both fibrous and globular proteins are constructed to a common plan, or at least that some common factor is involved in their method of synthesis. Bergmann and Niemann conclude that both the total number of amino-acid residues in a protein molecule and also the numbers of each of the various residues are expressible in the form 2^n3^m. On this basis, the minimum molecular weights of chicken egg albumin, cattle hæmoglobin, cattle fibrin, and silk fibroin are found to correspond to 288, 2 × 288, 2 × 288, and 9 × 288 residues respectively, which is equivalent to saying that *chemical analysis places not only two globular proteins—which would be expected—but also two fibrous proteins in one and the same scheme of multiple molecular weights*, the Svedberg scheme in fact, founded on ultracentrifugal studies of the globular proteins.

Now X-rays offer a way of supplementing the Bergmann argument, which requires a knowledge of the average residue weight, though there is no way of knowing this directly by chemical means owing to incomplete analyses. For β-keratin, for example, the average residue weight can be calculated from the density (for an estimate of the density of β-keratin I am indebted to Mr. H. J. Woods) and the X-ray measurements of the average residue dimensions. The best available data make it equal to (9·7 × 4·65 × 3·33 × 1·3)/1·65, or about 118, corresponding to approximately 0·85 gram-residues per 100 gm. of keratin. The number 0·85, when divided by values of 2^n3^m, should give the numbers of gram-residues of the various acids in 100 gm. of keratin. The accompanying table shows the results, to be discussed elsewhere, of the calculations for wool keratin:

	Acid	Frequency	Gm.-res. in 100 gm. wool	
			Calc.	Obs.
A	Glutamic	8 (2^3)	0·106	0·103
	Arginine	16 (2^4)	0·053	0·059
	Aspartic	16 (2^4)	0·053	0·054
	Tyrosine	32 (2^5)	0·027	0·027
	Lysine	48 ($2^4.3$)	0·018	0·019
	Tryptophane	96 ($2^5.3$)	0·008$_8$	0·009
	Histidine	192 ($2^6.3$)	0·004$_4$	0·004
B	Amide-N	9 (3^2)	0·094	0·098
C	Cystine†	8 (2^3)	0·106	Mean value
	Methionine	192 ($2^6.3$)	0·004$_4$	Mean value
D	Leucine	9 (3^2)	0·094	0·088
	Alanine	16 (2^4)	0·053	0·050
	Proline	24 ($2^3.3$)	0·035	0·038
	Serine	32 (2^5)	0·027	0·028
	Valine	36 ($2^2.3^2$)	0·024	0·024
	Glycine	96 ($2^5.3$)	0·008$_8$	0·008

† Calculated as half-cystine residues.

It will be seen that the measure of agreement is quite good, and though it is difficult yet to prove that only powers of 2 and 3 are involved, there is sufficient evidence to warrant the belief that keratin also will be found to conform to the common stoichiometric plan. The following points may be noted with regard to the experimental data presented: (*A*) These are the most reliable, and require a molecule containing a minimum of 192 residues, including 17 basic residues. The equivalent weight comes to about 1,330, which agrees reasonably well with the estimate (about 1,250) given by acid absorption[8]. (*B*) If the number of amide groups is also a submultiple of the total number of residues, which is not unlikely, the latter would then be at least 2 × 288 (mol. wt. about 68,000), corresponding to hæmoglobin and fibrin. (*C*) The variable sulphur content of the keratins is a difficulty at the moment, for the cystine values do not fall into a limited number of groups corresponding to 1/6, 1/8, 1/9, etc., as might be expected, though the mean estimates, both for cystine and methionine, agree roughly with the theory. It might be argued that there is a mixture of proteins each obeying the same law, but in that case there is going

* I am under the impression that I am responsible for the original use of the word 'globular' in discussing protein types[1]; but of course it was never meant to imply the spherical shape only, but rather something bulky, as opposed to an extended molecular chain like cellulose.

to be trouble all round, and any number, whether belonging to the series 2^n3^m or not, could be claimed to fit the theory. It may be, though, that this really is the correct general solution, that *the numbers of amino 'sites', as in alloys and mixed crystals, are expressible in the form* 2^n3^m, *or whatever the law should turn out to be.* The law would then be directly apparent in ideal or limiting cases only. (*D*) These data are probably unreliable.

In explanation of their results, Bergmann and Niemann propose the hypothesis that "in every protein each amino acid residue is distributed throughout the entire peptide chain at constant intervals. The protein molecule therefore contains a great number of superimposed frequencies"[9]. But is not this impossible? The periods 8 and 9, for example, must 'clash' before we come to 72; and in general such a hypothesis involves more than one residue occupying the same place in the peptide chain. Again, Bergmann says[10], "The presence of so complicated a periodicity explains why the problem of X-ray photography is so different for proteins than in the case of substances with simple periodicity". But is it?

However, quite apart from these questions, it seems clear that we are now on the fringe of something very fundamental indeed in protein theory, and the moral value alone of Bergmann and Niemann's discoveries will be immense. Exact analyses of the proteins, though always laborious, need no longer be the thankless tasks they have been. There is a goal in sight.

I should like to express my indebtedness to Dr. J. B. Speakman and Prof. A. C. Chibnall for advice on chemical points.

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Nov. 8.

[1] Astbury, W. T., and Lomax, R., NATURE, **133**, 795 (1934). See also NATURE, **137**, 803 (1936); *Chem. Weekbl.*, **33**, 778 (1936).

[2] Astbury, W. T., and Lomax, R., *J. Chem. Soc.*, 846 (1935); Astbury, W. T., Dickinson, S., and Bailey, K., *Biochem. J.*, **29**, 2351 (1935).

[3] Astbury, W. T., and Marwick, T. C., NATURE, **130**, 309 (1932); Astbury, W. T., *Trans. Farad. Soc.*, **29**, 193 (1933); *Kolloid-Z.*, **69**, 340 (1934); *Chem. Weekbl.*, **33**, 778 (1936).

[4] Clark, G. L., *et. al.*, *J. Amer. Chem. Soc.*, **57**, 1509 (1935); Corey, R. B., and Wyckoff, R. W. G., *J. Biol. Chem.*, **114**, 407 (1936).

[5] Bawden, F. C., Pirie, N. W., Bernal, J. D., and Fankuchen, I., NATURE, **138**, 1051 (1936); Bernal, J. D., and Fankuchen, I., NATURE, **139**, 923 (1937); Best, R. J., NATURE, **139**, 628 (1937); **140**, 547 (1937).

[6] Astbury, W. T., NATURE, **137**, 803 (1936).

[7] Bergmann, M., and Niemann, C., *J. Biol. Chem.*, **115**, 77 (1936); **118**, 301 (1937); *Science*, **86**, 187 (1937).

[8] Speakman, J. B., and Stott, E., *Trans. Farad. Soc.*, **30**, 539 (1934); **31**, 1425 (1935).

[9] Bergmann, M., and Niemann, C., *J. Biol. Chem.*, **118**, 307 (1937).

[10] Bergmann, M., Harvey Lectures, **31**, 56 (1935–36).

Diffraction of Light by Ultrasonics at Oblique Incidence

IT is well known that the first simplified theory of the diffraction of light by ultrasonics, which Sir C. V. Raman and N. S. Nagendra Nath[1] put forward in 1935, explains many experimental facts in a very striking way. The main point of the theory is to neglect the bending of the light-rays in the sound field altogether and to attribute the observed effects wholly to the local variations of the optical length in the sound-wave. If a plane light-wave falls normally on a sound-wave, the incident wave-front becomes a periodic corrugated wave-front. At oblique incidence it follows from this theory[2] that the corrugation vanishes for certain angles of incidence φ_n which satisfy the equation

$$\tan \varphi_n = n \frac{\lambda^*}{L}; \quad n = \pm 1, \pm 2, \quad . \quad . \quad (1)$$

in which λ^* denotes the wave-length of the sound and L the breadth of the sound field; consequently there should be no diffraction spectra visible when the light is incident in any of these directions.

This consequence of the theory has never been verified experimentally. The vanishing of the diffraction effect at these angles of incidence can be seen at once by the use of divergent light and of a suitable optical arrangement (Fig. 1). An image of

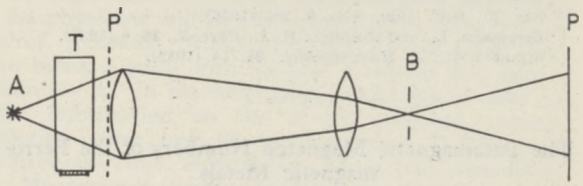

Fig. 1.

a point-shaped light-source A is formed in the plane B. The trough T with the liquid, in which the ultrasonics are generated, is placed in the divergent part of the light-ray. An image of a plane P' behind T is formed on the photographic plate P. On exciting the sound field, a number of diffraction spectra are produced in the plane B, one of which is transmitted by a suitable slit. The intensity distribution of the light falling on P is then an image of the intensity distribution of the light of this diffraction spectrum in P'. The dark bands visible in P correspond to the angles of incidence φ_n for which no diffraction takes place. A photograph, which was taken with sound-waves in water at a frequency of 15,000 kilocycles with a first-order spectrum is reproduced in

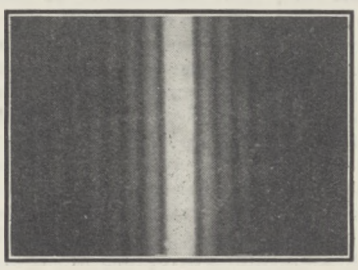

Fig. 2.

Fig. 2. In conformity with the theory, the angles φ_n are independent of the intensity of the sound-wave and the wave-length of the light used. The dependence of φ_n on λ^* is also in accord with equation (1). This has been verified in the range 4–15 thousand kilocycles, that is, for frequencies which are much higher than the domain of validity of this simplified theory with regard to other diffraction phenomena[3]. The dependence of φ_n on L is also in conformity with (1). The accuracy of these measurements is ± 5 per cent; for more exact measurements, an arrangement using parallel light would be preferable.

If the intensity of the sound is sufficiently high, the superposition of the intensities of all diffraction spectra gives rise to a phenomenon which has recently been described by L. Bergmann and H. J. Goehlich[4].

It should be emphasized that the experiments can only be carried out with an exactly plane sound-wave. Consequently a piezoquartz from Messrs. Carl Zeiss of Jena was used, which was cut according to the prescription of H. Straubel[5]. With an ordinary quartz plate one gets very distorted figures.

A detailed account of these experiments will appear shortly in *Helvetica physica Acta*.

F. Levi.

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Oct. 30.

[1] Raman, C. V., and Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, **2**, 406, 413; **3**, 75.
[2] *Proc. Ind. Acad. Sci.*, **2**, 413.
[3] Bär, R., *Helv. phys. Acta*, **9**, 265 (1936).
[4] Bergmann, L., und Goehlich, H. J., *Phys. Z.*, **38**, 9 (1937).
[5] Straubel, H., *Z. Hochfrequenzt.*, **38**, 14 (1932).

The Paramagnetic Magneton Numbers of the Ferromagnetic Metals

The paramagnetic magneton numbers of the ferromagnetic elements are derived from the linear portion of the $1/\chi,T$ curves above the Curie point. Of the three ferromagnetics cobalt, iron and nickel, only in the case of one, nickel, is the slope known with any degree of certainty. In the case of iron, Curie point 780° C., the phase change at 920° so restricts the temperature range over which measurements can be made that the $1/\chi,T$ curve never becomes linear. The high Curie temperature of cobalt at about 1150° C. makes precise measurements difficult, largely owing to evaporation and solid diffusion.

We have developed a method using a magnetic balance devised by one of us[1], for measuring accurately susceptibilities up to 1500° C. Evaporation of the specimen is to a large extent eliminated by using an atmosphere of argon at low pressure. The method has been used successfully to measure the magneton numbers of iron and cobalt, and to extend the temperature range of measurements on nickel.

It is well known that the α and δ phases of iron are identical (body-centred cube), and the intervening γ phase, which persists from 920° to 1390° C., can be removed by the addition of various metals which are soluble in the iron. The system iron-vanadium was chosen, in which about 5 per cent vanadium removes the γ phase completely. Our experiments show that the $1/\chi,T$ curve is linear above 900° C. The results for three different alloys are given in the accompanying table, from which the extrapolated value for pure iron is obtained. The second column gives the paramagnetic Curie temperature θ, whilst the third column gives the Curie constant per gram $C=\chi(T-\theta)$. In the fourth column are the values of the magneton number $p=\sqrt{3KC/N\mu^2}$, where K is Boltzmann's constant, N the number of atoms per gram, and μ the Bohr magneton $eh/4\pi mc$. It is worthy of note that the curve in the δ phase of iron (99·97 per cent pure) is linear, and when extrapolated to lower temperatures joins the α phase at the A_3 transformation. The value for the magneton number thus obtained is in close agreement with the value determined from the alloys.

Our measurements show that the curve for cobalt (99·8 per cent pure) is quite linear between 1230° and 1450° C., the upper limit of our observations on this metal. It was observed that continued annealing of the (electrolytic) specimens produced parallel but displaced lines on the $1/\chi,T$ graph, usually tending to lower the paramagnetic Curie point. These changes do not affect the Curie constant, whilst the Curie temperature ranges from 1130° to 1155° C.

The results on nickel agree with those of earlier workers up to 850° C., a linear relationship being followed from 500° C. Above 925° C. the slope decreases, giving a change in the Curie constant from 0·00548 to 0·00685.

A full account of the experiments, together with discussion of the results, will appear elsewhere.

	θ	$C=\chi(T-\theta)$	$p=\sqrt{3KC/N\mu^2}$
Nickel 500°–850° C.	377° C.	0·00548	1·61
925°–	265° C.	0·00685	1·78
Cobalt 1230°–1450° C.	1130°-1155° C.	0·0208	3·15
Iron–Vanadium 5%	828° C.	0·0222	3·16
4·1%	828° C.	0·0224	3·17
2·5%	828° C.	0·0225	3·18
(extrapolated) 0%	—	0·0227	3·20
Iron from δ phase	820° C.	0·0220	3·15

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[1] Sucksmith, *Phil. Mag.*, **8**, 158 (1929); **14**, 1115 (1932).

Joule-Thomson Effect and Quantum Statistics

In view of the numerous physical and astrophysical applications of the new quantum statistics it may be worth while to investigate the Joule-Thomson effect for a gas obeying Fermi-Dirac or Bose-Einstein statistics. The calculation is simple and runs on the usual lines. The results obtained are quite interesting. It is found that for a *degenerate gas*, degenerate in the sense of Fermi-Dirac statistics, *Joule-Thomson expansion produces a heating effect*, the rise in temperature for a given fall in pressure being greater, the greater the degree of degeneracy of the gas. In fact

$$\left(\frac{\partial T}{\partial p}\right)_i \doteqdot -\frac{g}{\pi kn}\left(\frac{3A_0}{4\pi}\right)^{2/3}$$
$$= -\frac{3}{8\pi^3}\left(\frac{4\pi}{15}\frac{gh^2}{m}\right)^{1/5}\frac{h^2}{mk^2}\frac{1}{Tp^{1/5}} \quad \cdots \quad (1)$$

where n denotes the number of particles (each of mass m) per unit volume, p the pressure, T the temperature, g the weight factor (for electrons $g=2$), k the Boltzmann constant and h is Plank's constant. A_0 is called the "degeneracy discriminant" and its value gives a measure of the *degree of degeneracy* (or of non-degeneracy in the case of non-degenerate gas).

$$A_0 = \frac{nh^3}{g(2\pi mkT)^{3/2}}.$$

For degeneracy $A_0 \gg 1$, and in non-degeneracy $A_0 \ll 1$.

It may be remarked for comparison that an adiabatic expansion produces cooling. In fact, as is easily seen, during an adiabatic process a degenerate

gas will remain degenerate and a non-degenerate gas will remain non-degenerate, the value of A_0 remaining constant during the process.

In the case of *non-degeneracy*, the Joule-Thomson effect is given by the relation

$$\left(\frac{\partial T}{\partial p}\right)_i \doteqdot -\frac{\beta A_0}{2^{5/2}nk}$$

$$= -\frac{\beta h^3}{2^{5/2}g(2\pi m)^{3/2}k^{5/2}T^{3/2}} \quad . \quad . \quad . \quad (2)$$

where β is to be taken as $+1$ for a gas obeying Fermi-Dirac statistics and as -1 for a gas obeying Bose-Einstein statistics. It is of interest to note that the *Joule-Thomson effect is independent of the pressure, and further it vanishes only when* $T \to \infty$.

In order to illustrate the order of magnitude of this effect, let us take the case of helium at 5° K. Helium obeys Bose-Einstein statistics and hence, taking $\beta = -1$ and substituting numerical values for the quantities involved, we find

$$\left(\frac{\partial T}{\partial p}\right)_i = 0{\cdot}076°/\text{atmos.}$$

However, this will not represent the thermal effect actually observed, which will depend largely upon the Van der Waals' type of deviations from the *classical* perfect gas. It is difficult to estimate exactly the contribution due to Van der Waals' deviations, but if we use the ordinary formula[1] to obtain some idea of it, we find (taking Van der Waals' $a = 0{\cdot}034 \times 10^6$ atmos., $b = 23{\cdot}7$ cm.^{3}) a value of 0·7°/atmos. for helium at 5° K. The Van der Waals effect is much the larger, but the statistical effect is still 10 per cent of it. It therefore seems possible that the Joule-Thomson effect under suitable conditions may provide an experimental test of the statistics obeyed by gases, say, helium.

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Oct. 14.

[1] Saha and Srivasava, "A Treatise on Heat", 476 (1935). We use the approximate equation in which the term $\frac{2a}{RTV}$ is supposed small compared to unity.

Interpretations of Atomic Constitutions

PROF. ANDRADE has had the great courtesy to attempt to answer my two questions in NATURE of November 20, they are :

(1) Whether the theory of the electrical composition of matter now fails.

(2) The difficulty of the nucleus tightly packed with protons.

Prof. Andrade avoids my first question in the most accomplished parliamentary form, telling me that in future I must not look on electricity as a fluid, and ask for a pot, pint, or firkin thereof. Interesting and informative, but the position is that the physicists announced to the world the electrical composition of matter. I did not do it. Why should I be lectured ? Now when the non-electrical neutron is established I ask a simple question : Have they been talking nonsense or not ? The general impression I get from Prof. Andrade is that they have. If so, the sooner they announce it the better.

Now as to the nucleus.

Prof. Andrade, when I get him into a difficulty over the protons packed together, answers with the readiness of a cash register, "No charge". But I notice the charge, with its defensive field, is still there to account for the superior penetration of the neutron over the proton in hitting and disintegrating the nucleus in bombardment.

Apparently the physicist changes the conditions at any time he likes to suit his convenience, but you cannot have it both ways. The quotation from Rutherford seems to me extremely sane, to the point, and logical. Referring to the nucleus he says it is "held together by very powerful unknown forces". If everyone was as frank as that and confessed to difficulties instead of riding round them, the popular explanation of modern physics would be no less attractive and a good deal clearer.

I hope these somewhat harsh words in debunking the physicists will not be construed as an attack on Prof. Andrade. Alone, valiantly he has come forth to break a lance with me and I respect and admire him for it. In his concluding paragraph he asks me for information on one of my subjects, namely, foreign policy, over the last ten years. It being near Christmas time, mutual help seems only seasonable.

Macroscopic events, ethnical considerations, and crowd psychology are subjects that the simple physicists will not understand, therefore I will try to tell the story in their own language.

Europe may be looked upon as a nucleus composed of individual protons, not however all of the same size or power, mixed up with a few neutrons with no charge and little mass. This is kept together by a strong force which prevents them flying apart, known as geography. This nucleus is not symmetrical as, included on its western edge, is a particularly powerful proton[1] that has "wave characteristics" of a definite type peculiar to itself. In the south there is what might be called a neutrino[2]. This has, some think, also wave mechanic aspirations. It is peculiar in this respect that its core is eternal[3] but its surround, some think, is ephemeral.

Now the real trouble is that just as in the atom there are electrons in their orbits far away from the nucleus, so in this case there are colonies also revolving. These used to be attached, so to speak, to separate protons, but some years ago the nucleus was subjected to a terrific bombardment which shifted these electrons from belonging to one proton to another. One very powerful proton, in mathematical language generally designated thus 卐, suffered severely in this respect, with the result that the nucleus as such is no longer stable. It has been found, however, that if the western proton adds to its charge[4], although a state of strain between the two protons is introduced, the nucleus qua nucleus becomes more stable.

I hope I have put this very difficult problem in simple terms for the physicists. I would have liked to have said a word on Newton's laws of gravity, as Prof. Andrade mentions them, but I feel that you, sir, must have your own laws on the same subject and that I am straining them.

J. T. C. MOORE-BRABAZON.

70 Pall Mall,
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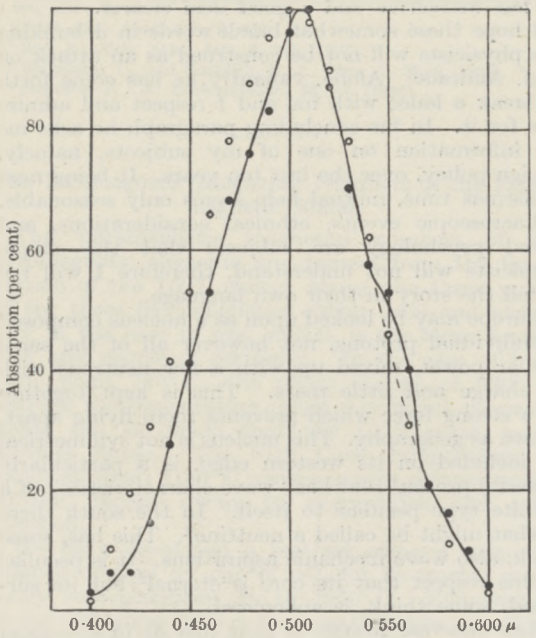
Nov. 22.

[1] Britain.
[2] Italy.
[3] Rome.
[4] By re-arming.

Absorption Curve for Visual Purple and the Electrical Response of the Frog's Eye

LETTERS in NATURE by Dartnall and Goodeve[1] and by Wald[2] have revived the question concerning the physiological significance of visual purple and visual yellow. Dartnall and Goodeve discuss the scotopic luminosity curve and compare it with the absorption curve for amphibian visual purple, determined by Lythgoe[3]. Attention may perhaps be directed to the fact that the retinal equivalent of the frog's luminosity curve has been measured by Granit and Munsterhjelm[4] with the aid of the electrical response. In this work, 'luminosity' was obtained in terms of the amount of potential in millivolts of the initial positive *b*-deflection of the electroretinogram in response to stimulation with an equal energy spectrum.



We lacked then, and still lack, data showing the relation between amount of potential and energy absorbed (intensity), and therefore had to neglect the area of the curves showing size of *b*-wave against wave-length. However, recent interest in this problem may to some extent be satisfied by a calculation of the frog's 'luminosity' curve, that is, the physiological absorption curve, on the basis of the fact that at low intensities, such as were used by Granit and Munsterhjelm, the *b*-wave according to Chaffee, Bovie and Hampson[5] is proportional to the square root of the intensity. This is a general equation that probably will not hold for all the twenty-seven somewhat differently distributed 'luminosity' curves measured by Granit and Munsterhjelm. But it should be acceptable if their 801 values are averaged together.

Applying the equation of Chaffee *et al.* to the average curve of Granit and Munsterhjelm (their Fig. 7) we obtain the effective intensity from the amount of potential at each wave-length. The effective intensity must be proportional to energy absorbed. Finally, following Dartnall and Goodeve, we correct the absorption curve computed from the electrical responses by multiplying by the value of the quantum at each wave-length. This gives us curve above.

The dots represent the 'physiological' absorptio curve, the circles around it Lythgoe's curve for th absorption of visual purple in solution (his Table column 2). Both curves refer to *Rana esculenta*. Th hump in our curve between 0·550–0·560 μ is place at the maximum of the cone curve of the san species, determined after light adaptation with th same apparatus by Granit and Wrede[6]. It probabl signifies that in this region of maximal cone sensitivit some low threshold cones have succeeded in influencin the measurements. However, the main result obviously that there is a reasonably good fit in th long wave-lengths, but that even the 'correcte absorption curve for visual purple, used for com parison, is higher in the short wave-lengths.

Dartnall and Goodeve, coming to the same co clusion, prefer Lythgoe's uncorrected values an suggest that the greater absorption by visual purp in the short wave-lengths is due to 'yellow impurities Their comparison refers to the human scotop luminosity curve. This may be the correct explan tion of the discrepancy, so far as measurements electrical responses at low intensities or huma absolute thresholds are concerned. But it is a interesting and, perhaps, significant fact that w obtained a hump at about 0·460 μ when the scotop eye was stimulated with a brighter spectrum (Gran and Munsterhjelm), and that the otherwise syn metrical cone curve had an 'appendix' of relativel too large responses in the same region (Granit an Wrede). It should be a relatively easy task to dete mine by means of the electrical responses whethe all the yellow substances are internal filters or som perhaps physiologically active photochemical sub stances.

We hope to be able to publish such measuremen in due course.

RAGNAR GRANIT.

Physiology Institute,
University, Helsingfors.
Oct. 10.

[1] Dartnall and Goodeve, NATURE, 139, 409 (1937).
[2] Wald, NATURE, 139, 587 (1937).
[3] Lythgoe, *J. Physiol.*, 89, 331 (1937).
[4] Granit and Munsterhjelm, *J. Physiol.*, 88, 436 (1937).
[5] Chaffee, Bovie and Hampson, *J. Amer. Opt. Soc.*, 7, 1 (1923).
[6] Granit and Wrede, *J. Physiol.*, 89, 239 (1937).

Effect upon Sex Behaviour of a Diet Deficient in Vitamin E

DIETS deficient in vitamin E produce sterility the male rat and ultimately extinguish the se drive[1,2]. Preliminary observations suggested th the behavioural disturbances were not clearly relate to, and dependent on, genital degeneration. Extende tests were therefore undertaken on 76 male ra reared on a diet lacking in vitamin E but adequa with respect to vitamins A and D and containi sufficient yeast.

Behaviour differed greatly. In some animals se behaviour was normal during the first months of th experiment. In others it was disturbed during th period, the abnormalities resembling those describe as a result of partial hypophysectomy[3]. In abou 25 per cent of the animals no overt sex behaviou was observed at any time. As the experiment pr gressed, disorganization of sex behaviour took pla in those animals which mated during the first stag of the experiment. Both structure and intensity behaviour were affected; the males mounted bu failed to complete the sex act.

Maturation of the glans penis and activation of the accessory genital glands took place in all animals. After disorganization of sex behaviour had become apparent, fairly large quantities of gonadotropic hormone prepared from pregnancy urine were administered and resulted in excessive development of the genital glands. Yet this hormone failed to evoke normal sex behaviour. Gonadotropic hormone prepared from the urine of an oophorectomized woman was similarly ineffective. But gonadotropic extract prepared from the blood of a pregnant mare invoked mating in 60 per cent of inactive males within three to five days. The same effect was obtained with some aqueous anterior lobe extracts.

The results of the present study resemble those obtained in experiments on total and partial hypophysectomy. Total ablation of the pituitary extinguishes sex behaviour, partial ablation is apt to produce disturbances of structure and/or intensity of the drive. The resemblance between animals reared on an E-deficient diet and hypophysectomized males respectively extends to the effect of suitable extracts: these restore sex behaviour in either group. It would appear, then, that the dietary deficiency affects sex behaviour by disturbing the erogenous function of the anterior pituitary. It is also interesting to note that since the completion of this work Miss M. M. O. Barrie[4] has published evidence of hypopituitarism produced by vitamin E deficient diets in rats and their offspring.

The procedure used in these experiments makes it possible to eliminate the erogenous function of the pituitary without surgical ablation and the consequent cachexia, stasis of growth and other general adverse effects. But it should be added that the deficiency produced in these experiments may not be wholly referable to the absence of vitamin E; some other deficiency may have existed, since we were not successful in obtaining normal sexual behaviour by addition to the basal diet of vitamin E (wheat-germ oil or its concentrates). Since disorganized sex behaviour was observed even in males whose basal diet was supplemented with vitamin E from weaning onward, failure to repair the defect cannot be attributed solely to irreversible changes produced by vitamin E deficiency.

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London, W.1.

[1] Evans, H. M., and Bishop, K. S., *Anat. Rec.*, **99**, 447 (1922).
[2] Mason, K. E., *Am. J. Physiol.*, **95**, 64 (1933).
[3] Wiesner, B. P., and Sheard, N. M., NATURE, **132**, 641 (1933).
[4] Barrie, M. M. O., NATURE, **139**, 286 (1937); **140**, 426 (1937), *Lancet*, ii, 251 (1937); *Chemistry and Industry*, Proc. Biochem. Soc. 56, 1053 (1937).

Protective Effect against Experimental Rickets of Rats of a Single Massive Dose of Vitamin D

IT is a well-known fact that there is a very wide margin between the therapeutic and toxic doses of vitamin D. It may safely be stated that a thousand times the therapeutic dose is quite harmless, at least for rats. It seemed to be worth while to investigate whether such a large dose if given intramuscularly would render rats immune against rickets for a long period.

Two pairs of young rats were placed on the rachitogenic diet McCollum No. 3143. To each of the first pair 750 international units of vitamin D were injected intramuscularly, while the other pair remained untreated. X-ray photographs were taken at weekly intervals. The rats were weighed weekly.

Of the pair given the vitamin D injection, one remained free from any signs of rickets for eight months (died accidentally), the other for 14 months (end of the investigation). Their weights increased from the initial 40 gm. to about 165 gm., which can be looked upon as normal, taking into consideration that the animals were kept continuously on the restricted diet McCollum No. 3143. The control rats showed the usual picture: after two weeks on the rachitogenic ration, severe rickets developed, after five to six weeks, decline of weight began and the animals died within three months.

The experiment shows that a single massive dose of vitamin D given as an intramuscular injection, was able to protect rats living on a rachitogenic diet from rickets.

H. ROTTER.

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Trisomic Mutations in Jute

Corchorus capsularis Willd., the common jute plant, has usually 14 chromosomes in the diploid state. No other number has been reported in the species or varieties of jute.

Fig. 1.

LEFT: TRISOMIC MUTANT PLANT; RIGHT: NORMAL JUTE PLANT.

In the course of cytogenetical studies a variant plant was discovered in the jute cultures which is characterized by much smaller and deeply serrated leaves. The plant proved to be highly sterile, setting a few seeds. Cytological studies have revealed 15 chromosomes in the root-tip cells as well as in the pollen mother cells. Selfed seeds collected from this mutant were grown this year. In Fig. 1 a typical mutant in the flowering stage is shown beside a

normal from the same pedigree culture. The differences are such that the mutants are easily recognizable. The trisomic is distinguished from the normal plant, from which it arose, not merely by single visible differences but also by a complex of characters which seem to be inherited as a whole in the offspring.

The leaf is the part of the plant which is most conspicuously affected, and I can pick out readily the trisomic mutant from the seed pan before the opening of the second leaves. The leaves are narrower, pointed and much more serrated than the normal. The two hood-like appendages generally present at the base of the lamina in all the normal varieties of jute are totally absent in the trisomic mutant. The petiole is on an average 2·1 cm. in length while those of the normal measure 3·3 cm., the lamina is 4·2 cm. × 1·6 cm. in size, the normal being 6·2 cm. × 3 cm. on an average. Axillary branches extrude from the axil of the leaves, causing irregular branching and increasing the strangeness of appearance of the trisomics. Flower buds are much smaller, stamens fewer in number, ranging from 10–16, whereas in normal plants the stamens are 15–24. Some of the stamens in the mutant are deformed and transformed into petals. Anthers are generally empty with aborted pollen grains; ovary with trifid or 4-fid stigmas, the normal being single and undivided; capsule smaller, seeds very few, with a low fertility.

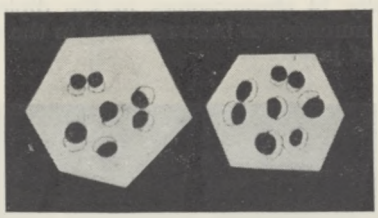

Fig. 2.

METAPHASE I FROM NORMAL (LEFT) AND TRISOMIC PLANTS (RIGHT), SHOWING PAIRS OF BIVALENTS SECONDARILY ATTACHED.

Study of the pollen mother cells at diakinesis revealed six pairs of bivalents and a trivalent frequently, as also seven pairs of bivalents and a univalent. At metaphase I, the trivalent divided as usual, two chromosomes passing to one pole and the third to the opposite pole. Sometimes a lagging univalent was noticed in the first and second division.

The trisomic mutant thus produces dimorphic gametes with 7 and 8 chromosomes. The breeding behaviour of the trisomic shows that when the mutant is selfed or crossed with normal pollen, it produces a large number of trisomic mutations in the offspring. But when the normal is used as female and trisomic as the male, the percentage of trisomic in F_1 is reduced to a considerable extent. This shows that egg cells with one extra chromosome are more effective in fertilization.

With regard to the origin of this trisomic mutation, it has been noticed that the normal sometimes throws trisomic plants under field conditions. Cytological studies of the normal plants with 14 chromosomes showed failure of pairing of one bivalent in some of the pollen mother cells. At metaphase I, eight chromosomes pass to one pole and six chromosomes to the other. It is possible that the same thing happens in the megaspore mother cell. The trisomic most probably arises from the mating of an egg cell with 8 chromosomes to a normal 7-chromosome pollen grain.

It may also be mentioned here that the cultivated varieties of jute are usually regarded as diploids. But chromosome morphology and meiotic chromosome behaviour indicate that jute is a secondary polyploid. The metaphase I (Fig. 2) from normal and trisomic shows pairs of bivalents secondarily associated. The maximum association observed is two groups of two bivalents, the other three bivalents remaining separate. It is therefore suggested that the basic number of *C. capsularis* is $n = 5$, and that the present number $n = 7$ is secondarily balanced.

An analysis of the genetic constitution of different trisomic types obtained is proceeding, and the use of trisomic ratios in locating the genes affecting different characters is being studied.

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Sept. 27.

Wild Birds and Butterflies

PROF. G. D. HALE CARPENTER has recently published "Further Evidence that Birds do attack and eat Butterflies"[1]. I have read this paper with great interest, and while I am fully aware that the observations contained therein approach the subject from rather a new angle, they are, to me, quite unconvincing in so far as they claim more than that butterflies constitute but the merest fraction of a bird's food.

I am surprised that Prof. Carpenter is apparently unaware of the evidence I set forth in a letter in NATURE in 1929[2]. The observations there were made by men with long experience, and specially trained observers of the stomach contents of wild birds. None of them was likely to overlook the scales of a butterfly's wing, the spicules of worms, the eggs of insects, or the limbs or cuticle of an isopod, and yet none of them found butterflies in an appreciable percentage in upwards of 100,000 stomach contents.

No one can deny that birds do snap at the wings of butterflies. Sir Guy Marshall has chronicled a long list of such cases[3]. On rare occasions they may possibly eat the bodies, but these cases, in my opinion, are few and far between.

Many years ago I had planted in my garden a new variety of lettuce, and I was puzzled at finding the leaves cut in this fashion Λ. Careful observation soon proved that house sparrows, chaffinches, tits, robins and thrushes were the depredators, but it would be unscientific to chronicle these species of wild birds as enemies of lettuce, or to say that such food constituted anything but an infinitesimal fraction of their food.

WALTER E. COLLINGE.

Yorkshire Museum,
York.
Nov. 8.

[1] *Proc. Zool. Soc.* (Ser. A), 223–247 (1937).
[2] NATURE, 334, 335 (Aug. 31, 1929).
[3] *Trans. Entom. Soc. Lond.*, 329–383 (1909).

DR. W. E. COLLINGE is apparently under a misapprehension as to the degree to which it is claimed that birds eat butterflies. I do not think that it is ever claimed that these insects form the principal food of any bird; only that they are eaten to an extent sufficient to have a selective effect, and I

believe that work by Prof. R. A. Fisher has demonstrated mathematically that this extent need be very much less than was previously supposed.

Dr. Collinge's point of view on this question seems to be expressed by his phrase "No one can deny that birds do snap at the wings of butterflies". It is because the imprints known as beak-marks imply something more than merely snapping at wings that for some years attention has been particularly directed to this subject, presumably that which Dr. Collinge mentions as an approach from a new angle. The clear Λ-imprint on the scales means that the wing has been definitely held in the beak but that the butterfly has escaped again. The high proportion of species with 'distasteful' qualities among beak-marked specimens is at present engaging particular attention; it is a very significant fact.

The observation by Mr. T. H. E. Jackson recorded in NATURE[1] deals with selective feeding upon butterflies by a bird to a considerable extent. The black-and-white African wagtail (*Motacilla*) habitually feeds upon butterflies, as shown by observations by Pitman[2], who mentions it daily "consuming dozens of butterflies", Major I. G. Owen in the Sudan[3], and Mr. J. P. Chapin[4], as well as by myself in Uganda[5].

An observation recently received from Mr. C. W. Chorley, an experienced field-naturalist in Uganda, may be quoted here: it is apt because attention has been directed to the lack of evidence of attacks upon migrating butterflies. Mr. Chorley wrote: "Once in Ankole I saw a migration of thousands upon thousands of butterflies [apparently a species of *Glycestha* = *Belenois*] travelling towards the west. The Yellow-fronted Bush Shrike (*Chlorophoneus sulphureipectus* Less.) was very numerous and at the foot of the perches there was quite a collection of butterflies' wings".

Finally, it is a little hard to be criticized for not mentioning a paper on *negative* evidence in a contribution entitled "Further evidence . . .". This was put together from notes hitherto unpublished to aid the provision of evidence which is said to be lacking. A discussion of the whole subject would have necessitated reference not only to the negative evidence but also to much recent positive evidence of which Dr. Collinge is apparently unaware, and would have been a larger undertaking than was attempted.

G. D. HALE CARPENTER.

University Museum,
Oxford.
Nov. 11.

[1] NATURE, 135, 194 (Feb. 2, 1935).
[2] Pitman, C. R. L., *J. Bomb. Nat. Hist. Soc.*, **33**, 204 (1948).
[3] Observation 22 of the paper under discussion.
[4] Chapin, J. P., *Natural History*, **22**, 66 (1922).
[5] Carpenter, G. D. H., "Mimicry", p. 69. (Methuen and Co., Ltd., 1933).

Points from Foregoing Letters

Dr. W. T. Astbury summarizes accumulating X-ray evidence for the belief that ultimately there will be found no real distinction between 'fibrous' and 'globular' proteins, and points out that the stoichiometrical data of Bergmann and Niemann indicate the same thing. He shows how X-ray measurements can be used to supplement the Bergmann argument, and calculates a stoichiometrical distribution of amino acid residues and provisional molecular weight for keratin, which also appears to fit into the new scheme.

Dr. F. Levi describes some experiments which confirm certain consequences of C. V. Raman and N. S. Nagendra Nath's first simplified theory of the diffraction of light by ultrasonics at oblique incidence hitherto not experimentally verified.

From measurements of the magnetic susceptibility of nickel, of cobalt and of iron-vanadium alloys (from which the susceptibility of iron can be obtained by extrapolation), Prof. W. Sucksmith and R. R. Pearce calculate the magneton number of these metals. The susceptibility for cobalt was found to be linear between 1,230° and 1,450°, and that of nickel between 500° and 925°. Above 925°, for nickel, the slope of the $1/\chi, T$ curve decreases.

Dr. D. S. Kothari and B. N. Srivasava point out that the heat absorbed or given off when a gas such as helium expands in a vacuum (Joule-Thomson effect) can, under suitable conditions, provide an experimental test to show whether the statistics of Fermi-Dirac or Bose-Einstein are applicable under those conditions. The authors give formulæ from which the magnitude of the effect may be calculated, both for 'degenerate' gases (which deviate from the gas and Van der Waals' laws) and for non-degenerate gases.

A curve showing the absorption of visual purple pigment (of the frog *Rana esculenta*), in solution, is compared by Prof. R. Granit with the 'physiological' absorption. The latter is obtained by calculating the 'effective intensity' from the luminosity curve determined from the response to an electrical stimulus. There is a reasonably good fit of the two curves for the longer wave-length, but for the shorter wave-length the absorption of the visual purple is higher than the 'physiological' absorption.

A diet deficient in vitamin E is found by Dr. B. P. Wiesner and A. L. Bacharach to have a complex disorganizing effect upon the sex organs and sex behaviour of the male rat. The addition of vitamin E to the basal diet does not bring about complete normality and some other factor may therefore be involved.

A single large dose of vitamin D injected in the muscle is found by Dr. H. Rotter to protect rats living on a rachitogenic diet for a long period.

The character and behaviour of a variant of the common jute plant, containing 15 chromosomes in the nucleus instead of the usual 14, are described by Dr. H. K. Nandi. It produces sex cells (gametes) containing seven and eight chromosomes, and breeding experiments indicate that the egg cells with one extra chromosome are more effective in fertilization. The behaviour of the chromosomes during nuclear division, the author states, leads to view that the basic number of chromosomes in the jute is five and that the present usual number, seven, is secondarily balanced.

Research Items

Fatigue and Air Movement in Rooms

WHILST the importance of maintaining the air in a public building or in the home at a reasonable standard of purity has been appreciated for many years, it is only recently that the importance of keeping the air in movement has been seriously considered. This question is discussed in a paper by J. R. Henderson in the *G.E.C. Journal* of August. It has been noticed that when no movement of the air at head-level is provided, a feeling of 'stuffiness' is experienced, accompanied by fatigue and loss of efficiency. The necessity for air movement is emphasized in the Home Office Welfare Pamphlet No. 5 (London: H.M. Stationery Office). It states that no work-room, even if lofty and spacious, is satisfactory without adequate air movement, and that the importance of this to physical health cannot be too widely understood. It is difficult to lay down definite rules concerning the optimum air velocity. It seems to lie between 50 feet and 200 feet per minute according to the prevailing temperature and humidity, and also to a certain extent to individual requirements. Some individuals, acclimatized to hot and humid conditions, are very susceptible to draughts. There are three principal methods of producing the necessary air movement: by high-velocity streams of air flowing through a system of ducts and fed by an air-conditioning plant; by table electric fans of the propeller type; and by ceiling fans. The high-velocity jets are usually part of an air-conditioning plant. For the home and small offices, the table or bracket fan is successfully used. If necessary, oscillating mechanisms are fixed to them to increase the area over which they are effective. Ceiling fans are the best means of producing air movement in large rooms. Owing to the large sweep of the slow-speed propeller, it is more silent than table fans. Their power consumption is small, being less than that taken by a hundred-watt lamp. When a regulator is used, a wide range of speeds is obtainable.

Digestion in Polyplacophoran Molluscs

A MORE complete account of the morphology, histology, mode of action of the alimentary canal and of the process of digestion in polyplacophoran molluscs than has hitherto appeared is now furnished by Vera Fretter (*Trans. Roy. Soc. Edin.*, May 1937). The principal type studied is *Lepidochitona cinereus*, but the following are also fully compared with it: *Acanthochitona crinitus*, *Ischnochiton magdalenensis* and *Cryptochiton stelleri*. The account is illustrated by plentiful, clear figures. The stomach in some species is complex and divided into a dorsal channel, with two longitudinal ciliated bands and a non-ciliated sac. The bilobed digestive gland has two ducts opening into the dorsal channel. It is only in this digestive gland that the soluble food material is absorbed. In *I. magdalenensis* and *C. stelleri* the intestine is complexly coiled. Food is conveyed through the œsophagus to the stomach by ciliary currents. The posterior œsophageal pouches secrete an enzyme with an optimum *p*H of 5·6 and an optimum temperature of 34° C. The stomach produces a proteolytic enzyme with an optimum *p*H between 4·29 and 4·86. The intestine is divided into an anterior and a posterior moiety separated by a valve which regulates the passage of food through the gut and also shapes fæcal pellets. The alimentary canal of the group resembles that of the lower gastropods in structure but differs in function.

Chironomid Fauna of River Mosses

AN interesting research has been carried on by Carmel F. Humphries and Winifred E. Frost during a biological survey of the River Liffey, the primary object of which was to investigate the food and growth of the brown trout (*Salma trutta*) from acid and alkaline waters ("The Chironomid Fauna of the Submerged Mosses" River Liffey Survey. *Proc. Roy. Irish Acad.*, 43, Section B, No. 11, 1937). The paper deals with the chironomid larvæ and pupæ found in these mosses, and the results are striking. One alkaline and one acid site were chosen, and although the species of mosses were different, it was found that the fundamental form was the same, so that the chironomids had similar habitats, and the total estimated number of larvæ is almost the same in the two sites. The dry weight of moss formed the same proportion of the whole sample in both places. Percival and Whitehead (1929) stated that in the River Wharfe "By far the greater proportion of the Midge larvæ of our area consists of Orthocladiariæ". The present authors find that it is the same in the Liffey and that there is a close quantitative similarity between the chironomid fauna at the two stations, the dominant subfamily in both cases being the same, and forming an almost equal proportion of the organisms present. The Orthocladiariæ constitute 95·9 per cent of the total chironomid fauna at Straffan, the alkaline site, and 98·6 per cent at Ballymutton, the acid site; the remainder is composed of Tanytarsariæ, Chironomariæ and Tanypodinæ. The seasonal distribution of all the chironomid larvæ as expressed in the graph shows that the seasonal abundance of the larvæ from the acid and from the alkaline waters is almost identical.

Citrus Manuring

AN outstanding example of the application of modern statistical methods to the elucidation of interacting factors in the nutrition of fruit trees on a commercial scale is presented by F. G. Anderssen in a recent investigation on citrus manuring in South Africa (*J. Pom. and Hort. Sci.*, 15, 2, 117; 1937). The experiment was designed to determine the influence of the common artificial fertilizers on the composition and quality of oranges and on their keeping quality. 2,500 Washington Navel orange trees comprised the experimental material, and these were manured with twenty different combinations of potash sulphate, superphosphate and ammonium sulphate, with applications of lime and the sowing of cover crops on some of the plots. Records were taken of crop weights, tree growth, rind thickness and keeping quality of the fruit, and chemical analyses were carried out on the fruit juice, rind and pulp. The data when analysed statistically gave

definite evidence of the effects of the various treatments. Applications of ammonium sulphate to the soil induced very marked increases in weight of crop and number of fruits, but there were no significant differences between applications of 2, 4 and 6 lb. per tree. A leguminous cover crop did not increase the nitrogen content of the soil or the size of crop, nor was crop size affected by superphosphate, potassium sulphate or lime. Calculations of correlations and partial regression coefficients showed that a high phosphorus content and probably also a high calcium content in the fruit were associated with low acid content and thin rind. High potassium content, on the other hand, caused high acid and thick rind. High calcium content caused an increase in the amount of wastage in storage due to mould, whilst nitrogen had the reverse effect. Sugar content and total soluble solids were increased by high nitrogen content, which was also shown to be necessary for the synthesis of phosphatic organic substances. The juice content of the fruit was not directly affected by any of the factors determined. The importance of balanced nutrients is emphasized, particularly in respect to nitrate and phosphate, which should be present in high concentration and suitable proportions.

Bending Wood by Hand

AT the Forest Products Research Laboratory of the Department of Scientific and Industrial Research an investigation has been made on the practice of bending solid wood by hand as distinct from machine bending, and the conclusions reached have now been published ("Methods of Bending Wood by Hand", *Forest Products Research Bull.*, No. 17. London: H.M. Stationery Office, 1937. 1*s.* net.) Of the bending machines available, there are few which are capable of producing a really large variety of designs, and, as a result, the most complicated bends are still almost invariably made by skilled hand-bending operators. The process is divisible into three distinct stages—the preparatory softening of the wood, the actual bending and the setting of the bend—and each of these is dealt with. In the first, steaming is regarded as the most efficient method, and the preparation and treatment of the blanks are discussed. Several different bending appliances are illustrated and described, including those for bending over pegs, and for bending between forms, the use of one form and a strap, and the need in certain cases for additional appliances such as clamps, end stops, wedges, etc., to prevent tension, shear or other failure of the wood. It is on the intelligent adoption of the right type of equipment that the combination of economy and success depends, and the text seeks to set out in general terms the principles by which one should be guided in these matters. Examples are given of difficult bends such as the Austrian chair-back type of bend, the S and sinuous types, and two-plane bends. The final setting stage has an important bearing on the finished bend; the conditions under which it must proceed are explained and particulars of the temperatures and precautions to be observed are set up. The Forest Products Research Laboratory invites inquiries from those who wish assistance in its subject, and places the results of its experience at the disposal of anyone interested. There is a wide field for quantitative investigation of this age-old process and the wood properties on which it is dependent.

Glaciers of the Wicklow Hills

IN an investigation of the glacial events in the Wicklow region during the later stages of the Glacial Period, Prof. J. K. Charlesworth has amplified the recent researches of Mr. A. Farringdon on this subject. Prof. Charlesworth's recent paper (*Proc. Roy. Irish Acad.*, **44**, B, No. 3) is entitled "A Map of the Glacier Lakes and Local Glaciers of the Wicklow Hills". A notable feature is the smallness of the glaciers on the western side compared with their development on the eastern side, but Prof. Charlesworth's most striking conclusion is that the whole upper surface of the mountain plateau, above about 2,000 ft., was covered by a firn field. In this conclusion, he differs from Mr. Farringdon. Prof. Charlesworth shows how the Irish Sea ice-sheet, in pressing against the flanks of the Wicklow Hills, closed the valley mouths and ponded the water into lakes which were drained by overflow valleys excavated across the main watershed, or projecting spurs. The withdrawal of the ice towards the north resulted in the more southern overflow valleys being smaller than the more northern.

Earthquake Swarm of Itô in Japan

THE remarkable swarm of slight earthquakes felt at Itô during the first half of 1930 has already been referred to in these pages (126, 326, 971). Mr. F. Kishinouye has recently studied their variations in frequency (*Bull. Earthq. Res. Inst.*, **15**, 785–826; 1937), and, if he had done nothing more than print, for the first time in English, a complete list of all the shocks recorded at Misako, his memoir would have possessed great value. From February 14 until June 26, the total number was 5735. A peculiarity of swarm earthquakes is that large numbers are crowded into a few hours of the day. On March 8, for example, the numbers in four successive hours were 54, 35, 19 and 29, while, during the rest of the day, there were only 24, and in each of 13 hours no shocks were felt. Such concentration, of course, limits the determination of seismic periods, and it is not surprising that the existence of a diurnal period is regarded by the author as doubtful. The diagrams representing the height of the tide and the hourly numbers of earthquakes recorded at Misako seem to show that earthquakes are most frequent at the times of low water, but Mr. Kishinouye does not admit any connexion between them owing to the small amplitude of the semi-lunar period. An interesting result follows from the comparison of the diagrams of the frequency and seismic energy of the Itô earthquakes, namely, that the strong earthquakes occurred as a rule during intervals of great frequency.

Vitamin C in the Potato

BEFORE the potato was introduced into the Netherlands, scurvy was a very common ailment; to-day the potato is the chief source of vitamin C in the dietary of the Dutch people. In the few determinations of the vitamin C content of potatoes that have been published, no regard has been paid to the possible differences between varieties or to the possible influence of the conditions under which they are grown. These points have recently been investigated by J. B. H. Ijdo, of the Hygiene Laboratory of the University of Utrecht, and his results are recorded in the *Landbouwkundige Tijdschrift* of August–September 1937. He has found that the vitamin C

content of thirteen varieties of potato grown in the same conditions varied from 25 to 63 per cent, whereas samples of the same variety showed an average difference of only 10 per cent. Locality of growth was also found to influence the content of vitamin C in potatoes of the same variety; the greatest difference observed was 40 per cent for the variety 'Iris'. Practically no difference was found between the contents of small and large tubers, or between samples taken from the centre and the periphery of the same potato. The absolute amount of vitamin C was found to vary from about 10 mgm. to 20 mgm. per 100 gm. of fresh material, a result which is in keeping with those previously published by other investigators.

Atomic Distances in Crystals

THE empirical function used by Pauling, Brockway and Beach to relate interatomic distances to bond types has been used to predict the carbon-oxygen and nitrogen-oxygen distances. A large discrepancy occurs for the carbonate ion between the predicted distance of 1·32 A. and the distance reported for calcite. N. Elliott (*J. Amer. Chem. Soc.*, **59**, 1380; 1937) has now redetermined the C–O distance in calcite and the N–O distance in sodium nitrate by X-ray methods by Laue photographs. The parameters found are 0·2635 for calcite and 0·2394 for sodium nitrate. These lead to the values for the interatomic distances of C–O = 1·313 A. and N–O = 1·210 A. A comparison with the distances predicted by Pauling, Brockway and Beach is made, and agreement is found for the carbonate ion. In the case of the nitrate ion, however, the predicted value is 1·26, leaving a discrepancy of 0·05 A. It is suggested that this is due to a previously unrecognized factor, the effect of the resultant charge of an atom on its covalent radius. In the nitrate ion there is a double bond to a neutral oxygen atom and single bonds connecting nitrogen with a formal charge +1 with oxygens with formal charge −1. Resonance between the double bond and the single bonds would be expected to diminish the N–O distance by 0·05 A., so explaining the discrepancy. The phenomenon should be observed in other substances such as the tetramethylammonium ion, and experiments to test this prediction are planned.

Petroleum Fuels in Canada

LAST year the Canadian Department of Mines issued a Bulletin (No. 772) giving statistics of petroleum fuels marketed in Canada during the years 1933 and 1934. A further Bulletin (No. 780) is now available, which deals with comparable statistics for the year 1935. As in earlier years, petroleum fuels are divided into four main classes, namely, fuel oil, kerosene, gasoline and petroleum coke. First, tables are given showing quantities of each type marketed in Canada during 1935 and their distribution throughout the various Provinces, and then each class is considered separately. In this year, more than 85 per cent of fuel oil was processed in Canadian refineries, the rest being imported. Of this, more than 24 per cent of the total was used for domestic heating, 26 per cent for industrial heating and power, 7 per cent for tractor fuel and 41 per cent for fuel for rail and water transportations. Deliveries of kerosene in 1935 represented less than one fourteenth of the volume of fuel oil, or about one thirty-third of the total volume of petroleum fuels delivered. In fact, about 1 million gallons less kerosene were delivered in this year than in 1934. 65 per cent of the total sold was used for domestic heating, cooking and lighting, 23 per cent for tractor fuel and the rest for general miscellaneous uses. Gasoline statistics given in the report are not strictly comparable with those furnished for fuel oil and kerosene, as they merely represent the amounts recorded by the several provincial tax departments of the Bureau. Nevertheless, a general study of these tables shows that the provisional figure for total sales during 1935 exceeds that for 1934 by nearly 39 millions of imperial gallons.

Magnesium Alloys

THE low density—1·74—of magnesium has led in recent years to its introduction into industry for the production of light articles not subjected to excessive stresses in use, and a considerable amount of information is now available as to the strength of the material and of many of its alloys. The issue of the *Science Reports* of the University of Sendai, Japan, for September, contains a report by Messrs. H. Endô and S. Morioka to the Research Institute for Iron, Steel and other Metals on the corrosion of magnesium alloys containing manganese and silicon. The corrosion is measured by the decrease in weight of rods of the alloys 3 cm. long and 0·5 cm. diameter immersed in 0·1 normal solutions of common salt in water for periods of 5–30 days. The authors conclude that the following are the compositions of the alloys which show the greatest resistance to corrosion under the above conditions: For magnesium-manganese alloys cast, Mn exceeding 2 per cent; annealed at 470° C., Mn exceeding 0·6 per cent; for Mg-Zn-Mn alloys, Zn 2–6 per cent, Mn 0·6–2 per cent; for Mg-Sn-Mn alloys, Sn 2–8 per cent, Mn 0·5–2 per cent; for Mg-Zn-Si alloys, Zn 2–6 per cent, Si 0·05–0·8 per cent; for Mg-Zn-Al-Mn alloys, Zn 4, Al 6, Mn exceeding 1 per cent. They attribute the resistance to the formation of a film of $Mn(OH)_2$ or $MnO_2 2H_2O$, mixed with $Mg(OH)_2$ on the surface.

Oriented Crystallization

THE July issue of the *Memoirs of the College of Science* of the University of Kyoto contains descriptions of two methods of obtaining crystals with a particular axis oriented in a given direction. The first, due to N. Matsumoto, consists in forming the crystals between the fibres of a bundle of stretched rayon threads by dipping the bundle into a saturated solution of the substance and then allowing the solvent to evaporate in the air. On examining the bundle under X-rays, he finds that the patterns due to the crystals can be distinguished from those due to the bundle of threads and that they indicate that one crystalline axis is parallel to the fibres. In the case of ortho-rhombic potassium chromate, for example, it is the a axis of $5{\cdot}88 \times 10^{-8}$ cm., and in that of monoclinic sodium sulphate the c axis of $11{\cdot}5 \times 10^{-8}$ cm. The second method, by S. Shimadzu, consists in allowing a metal plate to stand for a couple of days in a weak solvent, for example, silver in chlorine water. On examining the surface of the plate by electron diffraction, it is found that the (331) axes of the cubic micro crystals of the silver chloride are all arranged perpendicular to the surface of the plate.

Anniversary Meeting of the Royal Society

THE presidential address to the Royal Society was delivered by Sir William Bragg on November 30, opening with the usual brief references to the work of fellows of the Society who died during the past year. Their number this year is unusually high, namely, twenty-four fellows and two foreign members. A portion of Sir William's address is printed elsewhere in this issue (p. 954).

The report of the Council refers to a number of matters of interest, including the various activities of the Society during the 275th year of the Society's existence. On the accession of King George VI the Society was informed that His Majesty was graciously pleased to follow the practice of his predecessors in becoming the Patron of the Society.

His Majesty has also graciously signified his intention to continue the gift of the two Royal Medals which have been awarded annually by the Sovereign since their institution in 1825 by King George IV.

The proposal of the Council that the number of candidates selected for election annually shall be twenty instead of seventeen has been finally approved and the first election of twenty fellows will take place in March 1938.

The total expenditure authorized by the Council for the promotion of scientific research during the year under review was £33,500 and in addition nearly £10,000 was spent in the production of the Society's scientific publications. In these figures are included the Government grants in aid of scientific investigations and publications. The nature and scope of the research work undertaken by the research professors, fellows and students appointed by the Society and by other recipients of grants are indicated in a series of reports printed in the report; and they demonstrate to what good purpose the grants are being put.

When the Bermuda Oceanographic Committee held its first meeting in 1936, Dr. H. B. Bigelow, director of the Woods Hole Oceanographical Institution, proposed that an intensive programme of research into Gulf Stream and Atlantic Drift problems should be carried out jointly by the Woods Hole Oceanographical Institution and the Bermuda Biological Station. The proposals were strongly supported by the trustees of the Bermuda Station, who were, however, unable to undertake their share of the scheme without further financial assistance. Since fluctuations in the strength of the Atlantic Drift are suspected to have a marked effect on the sea fisheries of the United Kingdom, it was hoped that support for the proposed work might be obtained in Great Britain. The Committee recommended that the Council of the Society should make application through the Development Commissioners for a grant to cover the cost of the work. The Council agreed to these proposals; and, subject to certain conditions, a grant of £5,100 for capital expenditure and £3,500 a year for a period of five years has now been allocated for an approved programme of research. The scheme which has been approved includes provision for the employment of two scientific officers, who will assist Dr. J. F. G. Wheeler, director of the Bermuda Biological Station, and for an annual subvention to the station, which will be used as the base for the oceanographical work. The Committee is also providing a small research vessel to make the necessary observations at sea, and the selection and equipment of this vessel have been entrusted to a Ship Sub-Committee with Vice-Admiral Sir Percy Douglas as chairman. Unless unforeseen difficulties occur, it is expected that the research boat will be at work in the spring of 1938. The two additional members of the scientific staff have been appointed and will leave shortly for Bermuda. Dr. Ernest F. Thompson has been selected for the post of hydrologist and Dr. Hilary B. Moore for that of assistant to the director.

The Pilgrim Trust has offered to the Society 250 guineas annually for six years to allow an annual "Pilgrim Trust Lecture" to be arranged jointly by the Royal Society and the National Academy of Sciences and to be given alternately in London and Washington. The National Academy has agreed to co-operate. It is hoped that the first "Pilgrim Trust Lecture" will be given by an American scientist before the Royal Society in the summer of 1938.

PRESENTATION OF MEDALS

Copley Medal: Sir Henry Dale, C.B.E., F.R.S.

Sir Henry Dale's most important contributions to physiology and pharmacology lie in two different but closely related fields: (1) the isolation of certain chemical substances, notably histamine and acetylcholine, from animal tissues, and (2) the discovery of the part played by these in a large number of important physiological and pathological processes.

Dale's earlier work (1905–11) on the active principles of ergot led to progress in many allied subjects. The study of histamine, isolated from ergot extract and later found as a normal constituent of certain tissues, has modified profoundly our views of the capillary circulation and of the conditions known as 'wound shock' and 'anaphylactic shock'. In 1914, he became interested in the choline esters, and with extraordinary prescience singled out acetylcholine as the most interesting member of the series and pointed out the extreme likeness of its action to that of stimulating the parasympathetic.

In 1924, Loewi demonstrated that a substance indistinguishable from acetylcholine is liberated by the heart when the vagus nerve is stimulated. The researches of others, prominently among them Dale himself and his colleagues, have since shown that acetylcholine is liberated at many other junctions between conducting tissues, and the results with acetylcholine and adrenaline are embodied in the description of nerves as 'adrenergic' and 'cholinergic'. Recently convincing evidence has been given by Dale and his collaborators that acetylcholine plays an important, possibly an essential, part in the transmission of impulse from nerve to voluntary muscle: a discovery which has direct practical bearings on muscular fatigue and in various pathological conditions, and also is of the greatest interest in the theory of the mechanism of the nervous and neuromuscular systems.

As director of the National Institute for Medical Research, Dale has inspired and directed a wide variety of investigations outside his special field, and numerous investigators from many countries have worked under his guidance.

A Royal Medal: Prof. N. V. Sidgwick, O.B.E., F.R.S.

Prof. Nevil Vincent Sidgwick has always been primarily interested in the causes which determine molecular structure, and his earlier experimental work chiefly dealt with such subjects as tautomerism, and the vapour pressures, boiling-points and solubilities of isomerides. The development of the conception of the nuclear atom made possible for the first time a quantitative treatment of chemical valency other than purely formal, and the first steps in this direction were taken by Langmuir, G. N. Lewis and Kossel during, or just after, the Great War. Others followed with theoretical or physical extensions.

Sidgwick's post-War experimental work has all been concerned with particular problems of structure, utilizing to the full available physical methods of attack. To take a few examples, he has shown the existence of co-ordination compounds of the alkali metals, and has demonstrated the co-ordinating properties of the hydrogen atom. In particular, it was he who distinguished clearly the existence of a third and very important type of chemical binding, the so-called co-ordinated covalent link.

In 1927, Sidgwick published "The Electronic Theory of Valency", in which, for the first time, the most diverse structural phenomena covering the whole field of chemistry were rationally systematized. The book met with immediate and enthusiastic acceptance. In 1928, he played a leading part at a conference held at Munich to discuss chemical binding in its relation to atomic structure. In 1931, he lectured in the United States of America. He has continued his work of fruitful interpretation in a series of remarkable contributions made to the annual reports of the Chemical Society, and in his recent presidential addresses to the same Society on the subject of resonance phenomena in chemistry.

A Royal Medal: Prof. A. H. R. Buller, F.R.S.

Dr. Arthur Henry Reginald Buller was professor of botany in the University of Manitoba in 1904–36. His original contributions to science are mainly in the field of mycology and have been published in his "Researches on Fungi", six volumes of which have appeared.

These researches fall into two groups. The first comprises studies on the morphology, biophysics and physiology of the higher fungi, including the physiology of the mycelium and the organs produced on it, and especially of the production and liberation of spores. The second group deals with sex in the higher fungi, and Buller's studies on this subject rank among the most important that have been made. Particular mention should be made of his observations on the process of diploidization in the higher fungi, and of the discovery of heterothallism in the rusts in conjunction with his student Craigie, work which has revolutionized our conception of the life-cycle of these forms. Buller's studies have not been confined to one group of fungi, but include researches on Discomycetes and many groups of the Eu-Basidiomycetes, as well as on rusts and smuts. Reference should also be made to his "Essays on Wheat" and also to his efforts which made possible the publication of the translation by his friend W. B. Grove of the brothers Tulasne's monumental "Selecta Carpologia Fungorum".

Davy Medal: Prof. Hans Fischer

During the past twenty-five years Prof. Hans Fischer has been continuously engaged in the study of the chemistry of the porphyrins, the bile pigments and chlorophyll. Starting from the knowledge that the porphyrin molecule was built up of pyrrole nuclei, variously substituted in the different porphyrins, Fischer developed controlled methods of degradation which extended the possibility of the identification of the pyrroles in any given porphyrin.

With the accurate information acquired in this manner as a basis, Fischer proceeded, by bold and original synthetic work, artificially to prepare a large number of porphyrins of known structure, many of which proved to be closely related to or identical with natural products; his crowning achievement in this field was the synthesis of protoporphyrin, which, with iron, yielded hæmatin identical with that derivable from blood hæmoglobin.

From the porphyrins Fischer turned his attention to the bile pigments and was able to explain the fundamental chemical features of their relationship to hæmoglobin, thus paving the way for the biochemical work which is now proceeding in other laboratories and which promises to explain the actual mechanism of bile pigment formation in the body.

In recent years Fischer has applied his brilliant synthetic technique with outstanding success to the elucidation of the detailed structure of chlorophyll.

Buchanan Medal: General F. F. Russell

Frederick Fuller Russell graduated from Columbia College of Physicians and Surgeons in 1893, and began his career as a member of the Medical Corps, U.S. Army, in 1898, advancing through the various grades to that of colonel in 1917. He resigned in 1920. He was curator of the Army Medical Museum, Washington, D.C., from 1907 until 1913, and also instructor in bacteriology and clinical microscopy at the Army Medical School, where he performed distinguished service in developing and producing the typhoid vaccine which the Army has used with great effectiveness since that time. From 1920 to 1923 he was director of the public health laboratory service of the International Health Board and from 1923 to September 1, 1935, he was general director of the Board. It was during the period while General Russell was director of the International Health Division of the Rockefeller Foundation that the Foundation gave such material aid towards the establishment of schools of hygiene in various European countries. It also contributed largely to the All India Institute of Hygiene in Calcutta and to the Singapore Medical School. General Russell was also responsible for establishing the yellow fever unit in West Africa. Large grants were given to the Health Section of the League of Nations, and the fellowship scheme under the International Health Division was considerably extended.

Sylvester Medal: Prof. A. E. H. Love, F.R.S.

Prof. Augustus Edward Hough Love is most generally known as the author of the "Treatise on the Mathematical Theory of Elasticity" which has attained a universal reputation and remains the standard work of reference on this subject all over the world.

Before the first edition of Love's treatise was published in 1893, this branch of mathematical physics

received little attention and its results were often regarded by engineers with suspicion. During the intervening years it has gradually established itself as one of the most reliable mathematical theories of continuous media and, unlike its sister science of non-viscous hydrodynamics, its results have been increasingly verified in practice. That this has come about is due in great part to the influence of Love's "Treatise", which, indeed, like Lamb's "Hydro-dynamics", is far more than a mere treatise and embodies a vast amount of original work.

Looking at Love's other work there is a great volume of research dealing not only with elasticity, but also with hydrodynamics and electromagnetism. His earlier work was mostly on hydrodynamics, particularly vortex motion and wave-motion. He returned also at various times to electrical problems, especially those relating to the propagation, scattering and transmission of electric waves. His elastical investigations range over an exceedingly wide field, from the equilibrium of beams and plates of various shapes to the study of vibrations in a variety of difficult cases and to the applications of the theory of elasticity to problems connected with the earth.

Hughes Medal: Prof. E. O. Lawrence

Prof. Ernest O. Lawrence, professor of physics in the University of California, is the inventor (1932) of the cyclotron, the most important instrument of physical research since the C. T. R. Wilson expansion chamber, whereby ions are accelerated in a magnetic field and move within two half-cylinders which change electrical polarity in rhythm with the circulating ions, so that deuterons have been spirally speeded in a vacuum to velocities due to three million volts, and these deuterons, impinging on beryllium, have produced neutrons and protons in great number, and some of the protons have been projected through the equivalent of forty centimetres of air. Many elements have been proved to be radioactive when thus bombarded by high-speed protons or deuterons.

Hydrogen molecular ions have been used also as bombarding elements with velocities due to five million volts. Such high-speed ions are available for developing the theory and practice of atomic disintegration, and Prof. Lawrence and his co-workers are playing a leading part in this development.

Racial Evolution and Archæology*

IN Huxley's day the Neanderthal calvaria was the only hominid not clearly included in the *Homo sapiens* group available for study; but since his time other skulls have been found, which make it evident that there were several hominids widely scattered over at least the northern hemisphere of the Old World, while the Broken Hill skull from Rhodesia may be taken as evidence of the penetration of one of these types into Africa south of the equator. There is thus conspicuous evidence already for an early stage of evolution of the unique capacity for migration that man has demonstrated.

W. D. Matthew suggested the plateau of Central Asia as the original home of man; but, on the whole, this is to be set aside, in part at any rate, for several reasons. It may well apply to the early beginning of hominid forms; but North Africa and south-west Asia, as Darwin suggested long ago, seem to have played the great part in the early evolution of the modern races. Here, broadly speaking, we have indications of important contributions to the full evolution of man as working themselves out to make our race increasingly different from the apes of the forests and their edges, taking to a life away from the vicinity of the trees and evolving towards the erect posture, with more effective stereoscopic vision, adding to this the use of tools held in the hand, increased attention to hunting, and consequent differentiation of the work of the two sexes. While this sketch is still partly unverified, circumstantial evidence, including physiological indications that man's constitution adapts him to a temperate environment, makes this the most probable hypothesis to use and test as new knowledge grows.

We need not assume that all the stocks of modern man descend ultimately from one pair of beings, or even one small localized group. Nor should we assume that stocks of modern man in different parts of the earth have descended entirely from diverse ancestral hominids. We have to bear in mind the great migrations or drifts of humanity that have occurred from very early times onwards. It is the best hypothesis for the present to think of human stocks as of complex origin, with diverse constituents that may persist side by side to tell us of ancient drifts, as well as, perhaps, of diversities correlated with the different hominids concerned. Moreover, in every case we have to bear in mind the strong likelihood of adaptations to environment that may show themselves throughout a population, or may develop to different extents among its diverse constituents.

There is general agreement that the erect posture, improved stereoscopic vision and hunting developed among beings who lived a group life. All the indications we have for the past back to the Aurignacian-Capsian phases, even some relating to the Chelleo-Acheulean, suggest group life. Students of society have been apt to think of man as the creator of society. Ethical ideas have, in rather a perverse way, been set over against the natural tendencies. Yet it is an idea that is in large part false, if society is, as the scientific study of man suggests, a basic feature probably older than man. Self-conscious individuality is really a development within the matrix of society. Both grew side by side, with mutual adjustment, often after conflict, but with many movements towards considerable freedom of conscience, which may be considered the fine flower of the human social garden.

One cannot leave this aspect of the subject without reference to the importance of the woman's part from the earliest stages in the processes of both individualization and social evolution. Apart from maternal care, the development of the 'mother-tongue'

* Substance of the Huxley Memorial Lecture, 1937, delivered by Prof. H. J. Fleure before the Royal Anthropological Institute on November 9.

and other activities, cultivation grew from the food-collecting, rather than the hunting, function, that is, from the woman's side rather than the man's.

Prof. Fleure then proceeded to trace the evolutionary sequence in the development of the races of 'modern man', as classified according to physical character, and followed the probable course of migration of each in geographical distribution, correlating them with the development of phases of cultural life—hunting, agriculture, pastoral, and so forth—from the later palæolithic period onward. His conclusion on the question of the racial composition of the people of any one specific area is that "As something special in the way of immigration, conquest or other change has affected almost every region, each must be considered for its own sake and on the basis of its own story, if we are to understand the composition of its population". He went on to consider the complex racial composition of the European populations, pointing to the possibility, still not proved, of the association of a peculiar and characteristic mentality with racial type. It has not yet been possible satisfactorily to discriminate verifiable bundles including both physical and psychical characteristics that tend to be handed down together in the course of inheritance. Achievements of different peoples in literature, religion, government and so on may be brought into relation with what are thought to be prevalent types, but these are the achievements of exceptional people, while the opportunities and difficulties presented by different environmental or historical circumstances affect the result.

The warped interpretation of archæological data in support of the 'autarkic' idea, with the object of glorifying the Nordic race, was shown not to be in accordance with the facts. Prejudice claims that the Nordic race developed many of the chief features of European civilization of itself and spread them to more southern lands. So far is this from being true, that it can be shown that in the development of culture in the Baltic we are dealing, not with the advantages of racial purity and seclusion from contamination, but with repeated fertilizations of the north by ideas and techniques from the more advanced south.

In conclusion, Prof. Fleure stressed as an inference from the evidence of racial evolution and archæology the importance of a diversity of racial and cultural elements in a given population, as having tended to promote adjustments as between social groups and the recognition of justice rather than privilege and group ritual. The extrusion or suppression of active thinkers means the loss of the means of keeping in contact with the ceaseless process of change. "Any group," he said, "that claims for itself complete truth or knowledge really forfeits its status and title as a contributor to civilization, which is, in a very deep sense, the process of growth of freedom of conscience . . . The principle of freedom of conscience is claimed to be a large element in the scientific ideal, and a necessary part of it. Without it there can be little trust, even in alleged statements of fact, much less in the good faith of arguments. . . . Formerly it was widely held that basic general truths were known, and must be accepted and applied as guides of conduct. The scientific movement, on the other hand, has pressed the view that man's codes and creeds and conclusions are all provisional, that the truth is an ideal towards which we try to approach, but which we may never completely grasp. Freedom alone can, in the long run, keep us flexible enough for continuous adjustment to the ceaseless change that is the inevitable accompaniment of life."

The New Inventions Exhibition

THE Institute of Patentees' policy of going on tour has provided some interesting exhibits at the New Inventions Exhibitions at Sheffield (October 20–30) and Leeds (November 10–20) this year.

The exhibits varied from obvious, though ingenious, gadgets to complex mechanisms of scientific and social significance which require demonstrating to be 'understanded of the people'. The total number of exhibits was about 260, of which forty are by Leeds, and fifty by Sheffield inventors, and the remainder international. Doubtless these numbers would be greatly increased if, quite absurdly, inventors had not to be 'uncertainty-bearers'—a true function of Capital—as well as advance creators—an all-but-unbearable burden.

There are several new engines. One of these purports to drive a dynamo direct by a piston, itself steam-driven. The steam is produced suddenly by successive drops of water reaching a coil heated by the dynamo, 'cranked' over to provide starting heat. Another exhibit is a turbine engine claiming to yield around 40 b.h.p., and has its rotor driven by petrol-air explosion impulses, the gas mixture being induced by an automatic compression unit revolving together with a driving shaft at 2,000 r.p.m., whilst the rotor revolves at 30,000 r.p.m. *on the same shaft*, reduction gearing of 15 : 1 being required. Third, a two-stroke 'six' engine, which lends itself to mass production, has correct balance due to each power piston being balanced by a full-charging pump piston moving oppositely, and achieves noiselessness because of this and the absence of valves, tappets and gearing. There are but twenty-seven moving parts, and each crankshaft revolution has six power impulses giving even torque similar to an ordinary 12-cylinder engine.

The electrotor dust and smoke meter, already referred to in NATURE (**140**, 331, Aug. 21; 582, Oct. 2) abstracts the particles, however small, from dust or smoke suspensions over a wide range of application. Since dispersions actually consist of separate particles invisible to the eye, these must be microscopically counted to determine the dispersion. By providing an extensive choice of record areas in this light and convenient instrument, and achieving electrification, rotation, suction and centrifuging by one simple motivation, the countability of particles is maintained over a unique range of over 1,500,000 per c.c.

Pit-cage arresters; a trolley device making only *one* overhead wire necessary; and a bell rung inside when it rains, are other intriguing exhibits.

S. C. BLACKTIN.

Committee on Social Contacts of Science

THE Committee on Science and its Social Relations (abbreviation: C.S.S.R.), instituted by the International Council of Scientific Unions (I.C.S.U.) at its meeting in April last, and appointed in July (see NATURE, **139**, 870, May 22, 1937; and **140**, 358, August 28, 1937, for the members nominated), has recently met in London. It has elected the following officers: *President:* Prof. F. J. M. Stratton (Cambridge); *Vice-President:* Prof. S. Chapman (London); *Secretary:* Prof. J. M. Burgers (Delft). As a development of the original terms of reference, the Committee has adopted the following more precise statement of the objects of its activity: "to consider the progress, interconnections and new directions of advance in the mechanical, physical, chemical and biological sciences, especially in order to survey, at suitable intervals, and to promote, thought upon the development of the scientific world picture, and upon the social significance of the applications of science" (the corresponding French version reads: "pour examiner les progrès, les rapports réciproques et les orientations nouvelles dans les sciences mécaniques, physiques, chimiques et biologiques, spécialement afin de résumer, à des intervalles convenables, et de contribuer à l'étude du développement de la représentation du monde par la science et de l'importance sociale des applications de la science").

The Committee will begin its work by collecting materials for the preparation of a report and of bibliographies concerning the points mentioned, in so far as they are reflected in publications and statements of the years 1936–38, and in books which have appeared since the post-War period. As a general plan for the report a division has been suggested into the following headings: (1) outstanding developments and problems in scientific work; (2) new applications of science in human society; (3) interpretative work on the world picture as given by science; (4) thoughts on the social relations of science and the influences connected with its applications.

To obtain the necessary information, the Committee in the first place will address itself to the national and international bodies adhering to the International Council (national academies, research councils, etc., and international scientific unions), which are being asked each to appoint a correspondent interested in the activities of the Committee, who will act as a link between the organization by which he is nominated and the Committee. Further, an attempt will be made similarly to approach a number of organizations, both national and international, outside the I.C.S.U.; this in consultation with the Institut International de Coopération Intellectuelle of the League of Nations.

The Committee will appreciate it if persons or institutions who are interested in the work undertaken, and are in a position to make suggestions or to give indications concerning phenomena or points of importance, would write to the Committee. Communications can be sent to any of the members, and in particular to the secretary (address: van Houtenstraat 1, Delft, Holland).

Progress in Road Research*

IN the Second Annual Report of the Road Research Board it is shown that many road failures have been caused by the imposition on existing roads of loads much greater than they were originally constructed to carry, with the result that the foundations have given way. This is not surprising when it is recalled that many such roads started as cart tracks, and in the course of their evolution were next converted to water-bound macadam and later given superficial dressings of tar or bitumen or coverings of tar macadam or concrete, the foundations receiving no reinforcement to render them more fit to bear the heavier loads which these improved surfaces were attracting to the roads. The foundation of the road is therefore a vital factor in its durability, and is itself dependent on the supporting qualities of the subsoil, so that both for the building of a new road and for the adequate treatment of an existing road an examination of the subsoil is an obvious prerequisite. The report describes a field procedure whereby cylindrical cores of undisturbed material can be obtained from any site for the purpose of ascertaining its value.

The foundation usually consists of stones laid on the subsoil or, alternatively, concrete slabs may be used. The Road Research Station at Harmondsworth, West Drayton, Middlesex, has devised practical methods for the study and measurement of road aggregates and, while not yet in a position to place limits upon the maximum percentage of flaky or long material permissible in the bulk—a matter which at present is left to the judgment of the engineer—has adopted methods by which supplies of road aggregates can be compared with approved samples. No quantitative basis of the exact measurement of the roundness or otherwise of stone has as yet emerged and the terms employed are restricted to such descriptive words as round, sub-round, sub-angular and angular.

In connexion with the use of concrete in road work, the large quantities of material on the site, the time required to complete the work, and the variability of the British climate, combine to make conditions which defy uniformity in the product unless the means of rigid control can be provided. In the vibrator, a machine has been devised which

* Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of the Director of Road Research, for the year ended 31st March 1936. Pp. viii+136+9 plates. (London: H.M. Stationery Office, 1937. 2*s*. 6*d*. net.)

meets this difficulty and ensures that the sand and stone are brought to a constant water content before mixing. Bituminous road materials have also been under continuous review. These deform permanently under load to an extent depending on the time of application of the load, and the tendency to deformation under given conditions of loading can be adjusted by varying the viscosity of the binder and the grading of the aggregate. In some cases, cracks formed at low temperatures heal themselves in warm weather, and the application of heat to the binder may alter its characteristics. The effect of moisture reaching an aggregate before it is completely coated with binder is to promote disintegration. Thus load, time, temperature, rain and other weather conditions and their influences on bituminous constructions are being closely studied.

The length of life of bituminous roadways has been under investigation in full-scale experimental sections of roads, but the information available from these only comes in slowly and with difficulty, and the laboratory research which is in progress to overcome this delay ultimately must of necessity be slow until the results can be co-related with the full-scale tests. Three machines are in use at Harmondsworth to obtain the nearest approximation to continuous road conditions on limited areas. One of these presents the novel feature that the 5 ft. 6 in. diameter track under test is revolved under a wheel with stationary axis, which is fitted with a full-size pneumatic tyre. Its purpose is, in conjunction with laboratory tests, to eliminate undesirable factors in road construction and in surface dressings. Those which give favourable results under this wheel are tested again under the second machine, which operates with full-sized tyres under their rated loads and makes use of a track 38 ft. in diameter laid under ordinary conditions. Those materials which pass this second test are laid down to form a track of 110 ft. mean diameter and tested by a third machine by means of which a full-size lorry is run at maximum speed.

For the study of skidding, the standard machine consisting of a motor cycle and sidecar fitted with dynamometers as previously described is still used. The report points out that the limitations of this apparatus are its one size of tyre and load, both smaller than those of cars and commercial vehicles, the necessity for using smooth treads in order to obtain comparative results, and the fact that the machine records only side-way skidding. To meet these defects, another apparatus has been designed which will be towed by a two-ton lorry and will allow tests to be made with tyres of 27 in. diameter loaded up to 600 lb. A further apparatus has been designed and constructed at the Laboratory to make accurate measurements of surface irregularities, by giving a profile of the road surface.

It will thus be apparent that road research has now reached the stage of the active production of apparatus to measure the factors which are of importance in road construction. Although in recent years, as Dr. R. E. Stradling, the director of research, states in his survey, there has been a rapid advance in the methods of highway engineering, the absence of sufficient scientific knowledge has led to a certain amount of design and construction on the wasteful expedient of hit and miss procedure. The work of the Road Research Board very largely aims at the formulation of a science of road engineering, which will enable engineers to work on definite lines rather than by trial and error.

Science News a Century Ago

The Management of Bees

AT a meeting of the Ashmolean Society, Oxfo held on December 4, 1837, Mr. W. C. Cotton, Christ Church, read a paper on the management bees, showing the defective system pursued by c tagers and suggesting improvements. All that w required for bee-keeping, he said, is a small gard or even a few yards of ground before the door o cottage.

The great secret of success, Mr. Cotton observed, never to kill a bee. The smoke of the large fung or puff ball, when quite dry, had an intoxicati effect upon bees, and by its aid, weak swarms mig be united to strong swarms, and the combs might taken out of a full hive without injury to the b themselves. The method of uniting swarms at t conclusion of the honey season was first practised Mr. Thorley a century previous, and side boxes h been introduced about the same time by Mr. Whi Bees were of the greatest use in distributing t farina of fruits and flowers. Bees seldom liv beyond the year so that no apprehension need entertained that they would grow old and lazy. M Cotton had just published a pamphlet on bee keepi for cottagers (*Athenæum*).

Mails from India

IN the "Annual Register" for 1837 under the da December 8, it was said, "The project of ste communication with India through the Red Sea h been successfully accomplished, and is now in ope tion. The last communication was effected in for three days, including the stoppage at Alexandr The following are the particulars: The *Atlanta* l Bombay on the 2nd of October and arrived at Su on the 16th of October, with the mail of Septembe and at Alexandria on the 20th of October, fr whence the mail was despatched by her Majest ship *Volcano* on the 7th of November, and arriv at Malta on the 11th, and was despatched fr Malta to Gibraltar by her Majesty's ship *Fire-fly* the 16th of November, and was due here on Mond the 4th of December".

Alexander's Electric Telegraph

IN the *Athenæum* of December 9, 1837, it was sa "We have been admitted this week to a private vi of an ingenious model for an Instantaneous Te graphic Communication, by means of electric voltaic currents transmitted through metallic c ductors under ground, the invention of Mr. Alexanc of Edinburgh. The principle Mr. Alexander uses to have as many wires as will correspond with letters of the alphabet and thus, of course, the per in London can by applying the electric influence any wire apprise a person in Edinburgh that particular letter of the alphabet is indicated. T expense of such a telegraph from London to Ed burgh is estimated at £100,000. To test the pl various experiments have been tried in the Univers of Edinburgh, and we are informed with perf success. We may further mention that we ha this week been invited to inspect a Hydra Telegraph and we hope to be able to report on shortly."

Societies and Academies

Paris

Academy of Sciences, October 18 (*C.R.*, 205, 633–696).

MARCEL DELÉPINE : Obituary notice of Jean Baptiste Senderens.

KENTARO YANO : The change of the coefficients of a projective connexion.

GEORGES TZITZÉICA : Certain quadratic curves and the displacement of a parameter.

DAVID WOLKOWITSCH : The conoid of Plücker.

RENÉ HARMEGNIES : The torsion of curves traced on a surface.

ERNEST VESSIOT : Partial differential equations of the second order $F(x,y,z,p,q,r,s,t)=0$, integrable by the method of Darboux.

JEAN DELSARTE : A functional transformation relating to the theory of harmonic functions.

JOHN ELLSWORTH : Rapid changes in the tail of the Finsler comet, 1937*f*. A description of the changes shown by photographs taken between August 2 and 11. There was a second tail, and a marked change in position was shown in two consecutive photographs with an interval of 75 minutes.

LOUIS BERGERON and JOSEPH BETHENOD : The hydraulic tourniquet.

LÉOPOLD ESCANDE : The theory of flow through a depth valve.

MARCEL ATANASIU : Study of natural convection in liquids. Convection in castor oil. An electrical heater is placed in the centre of the castor oil and the temperature differences measured at different points in the oil after the whole has reached a steady state. The convection flow is deduced from these figures. The results are in agreement with the views of Vernotte and experiments of Bory on convection in air.

AUREL NICOLAU : The thermomagnetic properties and constant paramagnetism of the ion UO_2^{++} in some uranyl salts in aqueous solution. Neither uranyl sulphate or nitrate follows the law of Curie or that of Weiss : the paramagnetism is independent of the temperature.

JEAN DEBIESSE : Absorption spectra of microbial broths. The growth of micro-organisms in broth produces clear and characteristic modifications in the absorption spectrum. It is suggested that similar observations in the infra-red region and with Raman spectra would be of interest.

ALEXANDRE DUFOUR and FERNAND PRUNIER : The Sagnac effect.

MARCUS BRUTZCUS : The thermochemistry of oxygenated hydrocarbons.

FRANÇOIS BOURION and EMILE ROUYER : The determination of the total hydration of the ions of strontium nitrate.

RENÉ DELAPLACE : The pressure of some permanent gases at low temperatures in the presence of silica gel. The gases studied were nitrogen, oxygen, carbon monoxide and methane. A table is given showing the pressures measured for a range of temperature between −182° C. and −134° C. The figures show that it should be easy to separate the oxygen-nitrogen group from the carbon monoxide-methane group.

CLÉMENT DUVAL : The cobalt hydroxides. By the precipitation of aqueous solutions of cobalt salts with potash, six different precipitates can be obtained, varying in colour. The necessary conditions for the preparation of each variety are given, together with analytical figures.

GEORGES WETROFF : The oxide of phosphonitril, $(OPN)_n$.

LOUIS CHASSEVENT : The hydraulicity of slags.

ALFRED MAILLARD and R. FRIEDRICH : The products formed by the incomplete combustion of light liquid hydrocarbons. The combustion products were cooled to 15° C. and the condensate examined. Results are given for seven different petrols.

MLLE. MARIE LOUISE QUINET : The classification into two groups of the complex compounds of magnesium chloride with oxygenated organic compounds according to the nature of the oxygen linkage. The (OH) group, water and alcohols, gives complex molecules with six molecules attached to one molecule of magnesium chloride ; the =O group, aldehydes and ketones, attach three molecules ; the ether oxide, −O−, gives no complex compound, at least for temperatures above −20° C.

PAUL CHOVIN : Researches on Pechmann's colouring matters. The supposed isomerism of Pechmann and Kugel colouring matters.

JEAN DÉCOMBE : Syntheses by means of β-chlorethylated or β-vinyl ketones. The preparation of some homologues of 1-cyclohexene-3-one.

GEORGES DARZENS : The preparation of some glycerides of phenylacetic acid and their reduction to the corresponding alcohols. Application to the preparation of phenylethyl alcohol.

JEAN BEAUVERIE : The granular structure of chloroplasts : the *grana*.

WERNER MÜLLER and WILLIAM HENRI SCHOPFER : The action of aneurin and of its constituents on *Mucor Ramannianus*.

P. BONÉT-MAURY : The optical properties of bacterial suspensions. Four species of bacteria were studied and in each case the optical density was proportional to the bacterial concentration.

F. ARTIGAS : The emission of an ionizing radiation by the total ash of plants. The radiation was found to be proportional to the amount of potassium in the ash.

ALEXANDRE BESREDKA and LUDWIK GROSS : The role of the skin properly so-called and of the subcutaneous tissue in the evolution of malignant tumours.

Delhi

National Institute of Sciences of India, November 6.

M. ISHAQ : The O-O-Band of OD.

T. S. WHEELER : The theory of liquids.

H. S. PRUTHI and E. S. NARAYANAN : A study of the behaviour of some common varieties of sugarcane in reference to the attack of borers.

D. S. KOTHARI : Joule-Thomson effect and adiabatic changes in degenerate gas.

B. RAMAMURTY : The chemical fixation of nitrogen at low temperature and its significance in agriculture.

M. N. SAHARA and K. B. MATHUR : The propagation of electro-magnetic waves through the atmosphere.

B. N. SRIVASTAVA : Joule-Thomson expansion of a non-degenerate gas.

Moscow

Academy of Sciences (*C.R.*, 16, No. 1, 1937).

KH. SMALICKIJ : The functions of Le Roi, H. Poincaré and V. Stekloff.

M. KELDYŠ and L. SEDOV : The effective solution of some problems limited by harmonic functions.

STEFAN BERGMANN : Some values in pseudo-conformal images.

J. A. MINDLIN : The boundary dynamic problem of the theory of elasticity for a circle with given displacements.

V. SOKOLOVSKIJ : The design of a spherical shell.

V. S. KOSLOV : Determination of the elements of percolation flow under dams with three cut-off walls resting upon a permeable foundation of finite depth.

V. D. KUPRADZE : Solution of the general problem of the diffraction of electromagnetic waves.

V. K. ARKADIEV : The dispersion band and the skin-effect in the sinusoidal field and in the transitional one.

A. PROKOFJEV : Torch ion counter.

P. LAZAREFF : Theoretical study of the influence of mountain ascents and that of winds on peripheral visual adaptation.

N. MIHAL : The determination of the figure of the geoid from the anomalies in the horizontal gradients of gravity.

I. A. SMORODINCEV and A. M. FELDT : Determination of the dissociation constant of thyreoglobulin.

M. A. KLOČKO : The 'lake age' of the Caspian Sea and its volume at the time it became a closed basin.

K. S. ANDRIANOV and A. I. SMIRNOV : The problem of the genesis of vivianite.

P. O. SITKO : Frequency of lethals in the *X*-chromosome due to the irradiation of spermatozoa in the males and in the spermathecæ of the females of *Drosophila melanogaster*.

I. N. KONOVALOV and I. E. ROGALEV : The behaviour of nitrogenous substances during the vernalization of plants.

V. L. RYŽKOV and A. M. VOVK : A new disease of the onion (*Allium Cepa*).

(*C.R.*, 16, No. 2, 1937.

V. STEPANOV : Arithmetical demonstration of a theorem of B. Segal.

A. V. JOFFE and A. F. JOFFE : (1) Electronic semiconductors in strong electric fields. (2) Properties of the blocking layer of solid rectifiers.

H. MANDEL and P. KUTEJNIKOV : The full electrodynamics of material media.

N. S. KURNAKOV, A. V. NIKOLAEV and A. G. ČELIŠČEVA : (1) Heating curves of borates. (2) Specific gravity and hardness of natural borates and of the products of heating them. (3) Hydration heat and exothermic transformation of borate into inyoite. Some considerations on the transformation of borate.

V. V. ČELINCEV : Explanation of the disposition and inclination of rows of molecules in layers of organic acids according to röntgenograms.

B. P. NIKOLSKIJ and V. M. VDOVENKO : The potential difference between solid silver halogenides and aqueous solutions.

A. G. KOGAN and V. I. NIKOLAEV : Studies on the polytherme of the binary system HNO_3—HCl, and of the ternary system HNO_3—HCl—H_2O.

N. A. ORLOV and I. S. MUSTAFIN : Oxidation as a way to the formation of carbohydrates.

V. A. ŠPAK : A new method for differentiating rocks from borings by a counter recording gamma radiation impulses.

N. P. LUPPOV : The age of the "Upper Siderite clays" of the basin of the River Kuban (North Caucasus).

O. S. VIALOV : The mesozoides of Asia.

J. A. EFREMOV : Stratigraphic subdivision of the continental Permian and Jurassic of the U.S.S.R. on the basis of the fauna of early Tetrapoda.

V. I. CALKIN : The distribution of the common dolphin (*D. delphis* L.) in the Black Sea.

Forthcoming Events

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

Monday, December 6

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.—Prof. F. W. Twort, F.R.S. : "A Comparative Study of Filter-passing Bacteria and Viruses" (succeeding lectures on December 8, 10, 13 and 15).*

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles Sherrington, F.R.S. : "Jean Fernel" (Thomas Vicary Lecture (1)).

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Rev. W. L. S. Fleming, A. Stephenson and G. G. L. Bertram : "Scientific Work of the British Graham Land Expedition".

Tuesday, December 7

CHADWICK PUBLIC LECTURE (at the London School of Hygiene, Gower Street, W.C.1), at 5.15.—Dr. William Butler : "The Thames Estuary and the Problem of Sewage Disposal of Greater London".*

INSTITUTION OF CIVIL ENGINEERS, at 6.—Colonel W. Garforth : "Air Raids as they Affect the Work of the Civil Engineer".

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, Cavendish Square, W.1), at 7.30.—Prof. L. C. Martin : "The Present Limits of Microscopy".

Wednesday, December 8

INSTITUTION OF CIVIL ENGINEERS, at 6.15.—Dr. Brysson Cunningham : "Estuary Channels and Embankments" (Vernon-Harcourt Lecture).

Thursday, December 9

THE ROYAL SOCIETY, at 4.30 p.m.—Dr. R. W. Gurney and Prof. N. F. Mott, F.R.S. : "The Theory of Photolysis of Silver Bromide and the Photographic Patent Image".

Dr. A. L. Reimann : "The Temperature Variation of the Work Function of Clean and of Thoriated Tungsten".

ROYAL ASIATIC SOCIETY, at 4.30.—Prof. Doi : "Japanese Myth and Tradition".

Friday, December 10

ROYAL INSTITUTION, at 9.—Sir George Simpson, F.R.S. : "Ice Ages".

BRITISH INSTITUTE OF RADIOLOGY, December 8–10.—Annual Congress to be held in the Central Hall, London, S.W.1.

Appointments Vacant

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

LECTURER IN MATHEMATICS in the City of Leeds Training College—The Director of Education, Education Office, Leeds 1 (December 8).

PRINCIPAL of the Openshaw Municipal Technical School—The Director of Education, Education Office, Deansgate, Manchester (December 11).

LECTURER IN ANATOMY in the University of Birmingham—The Secretary (December 11).

PATHOLOGIST AND BACTERIOLOGIST in the Memorial Ophthalmic Laboratory, Cairo—Mr. H. H. Rew, The Examination Hall, Queen Square, W.C.1 (December 18).

ASSISTANT in the Observatory at the Cape of Good Hope—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Ref. C.E. 7106/37) (December 21).

GLASS TECHNOLOGIST to the Government of the United Provinces—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (December 31).

METEOROLOGISTS (Grade III) in the Meteorological Office—The Secretary (S.2.A.), Air Ministry, Adastral House, Kingsway, W.C.2 (December 31).

INSPECTOR OF METALLIFEROUS MINES AND QUARRIES in North Wales—The Establishment Branch, Mines Department, Dean Stanley Street, Millbank, S.W.1 (January 1).