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Processes of Organic Evolution

ONE of the difficulties about organic evolution is that it has not been and probably cannot be demonstrated in a strict sense, and although the indirect lines of evidence converge with such unanimity upon the probability of the theory that the scientifically trained mind is convinced, a loophole for doubt remains to the multitudes who must rely upon the dictum of authority one way or the other.

The evolutionist who rests upon his oars, convinced that the stream is running with him, misjudges the set of at any rate one considerable part of the current. "Le problème de l'Evolution paraissait plus près de sa solution, il y a quarante ans, que maintenant", wrote Prof. Caullery, and the critical examination of "le Transformisme" is a noticeable activity of French thought at the moment. In America the anti-evolution or Fundamentalist position is well entrenched. There in June the monthly magazine *Evolution*, described as "A Journal of Nature ; For Popular Education in Natural Science, to Develop the Open Mind", reappeared after a lapse of five years due apparently to lack of supporters interested in open minds ; and the editor, after interviewing 20,000 persons, says, "I am more convinced that there is a need and a real field for *Evolution* than I was before I started." He was advised if he wished to make a commercial success of his journal to change *Evolution* to some "less offensive" name. In Great Britain the feeling against evolution lies rather under the surface, but it exists, and we recall the surprise with which we listened to the announcement of a University student that she did not propose to answer any examination question upon evolution, because neither she nor her parents believed in it !

When, therefore, Sir Edward Poulton in the course of his charmingly reminiscent presidential address to the British Association on "The History of Evolutionary Thought, as recorded in Meetings of the British Association", which is printed in the Supplement to this issue of Nature, passed lightly over "the subject of organic evolution itself, *as generally accepted*" (our italics), he spoke truly of his scientifically minded audience, for he recalled only one example of opposition to a belief in organic evolution, and that was at the first meeting he attended, in 1881. But the swamping of two thousand scientific workers by a week-end influx of trippers during the Blackpool meeting gave perhaps a rough indication of the number of believers to the masses who do not understand evolution, who do not care, or who are actively or passively opposed. The position, however, is gradually changing. The idea of evolution, as understood to-day, is comparatively new, and the natural death of prejudice, together with the diffusion of knowledge in school and college, and particularly through the far-reaching voice of the radio, are paving the way for the general recognition of a process the idea of which has become a commonplace of scientific thought.

Evolution rests upon two primary or basic factors : the vital characteristic of organisms to produce variations, and the heredity which makes possible the establishment or perpetuation of these variations. Both aspects have been discussed at meetings of the British Association, but the tendency has been for debate to centre upon the secondary or guiding factors, the means by which the course of evolution has been directed. Here there has been controversy enough since natural selection took the field, and particularly since that

discussion in 1887 at Manchester upon "The Hereditary Transmission of Acquired Characters" in which Weismann took part, who all but strangled the idea of the inheritance of acquired characters at its resuscitation.

Into this controversy, Sir Edward Poulton in his address threw himself with gusto and with many recollections of the great debaters of the past, for he himself during the last fifty years has been in the forefront of the battle. Having nailed his colours to the mast, he picked here and there from the meetings of the last half-century opinions or evidences in favour of the efficacy of natural selection, notably from Prof. Alfred Newton and Canon Tristram, and against the inheritance of acquired characters by Ray Lankester.

The recalling of these contentions is a reminder of the difficulty of adducing real proof of any theory of evolutionism, and of the assumptions which the early followers of Darwin permitted themselves. Take the quoted case of Canon Tristram's larks of North Africa, where a sandy area has a long-billed, and a rocky district a short-billed species. The assumption made was that "the shorter-billed birds would be at a disadvantage in obtaining food from sandy areas but at an advantage among the rocks where strength is required". A plausible assumption, but, unbacked by a thorough analysis of the food consumed and the food available, no more than an assumption.

Compare Tristram's evidence with the more complete observation of bill structure made by Joseph Grinnell in Lower California, where in a peculiar area of meagre rainfall and high atmospheric humidity (a humid desert) he found that lesser size of bill was a common feature of birds as different as flycatchers, finches and woodpeckers. It is difficult, but not impossible, to assume that birds of feeding habits so diverse could all benefit by exactly the same kind of modification, so that, for each, environment should select similar variations. It is even more difficult to make the assumption, since other common modifications occur in all these birds, such as deeper coloration and certain proportions of wing and tail. What seems to be clear is that environment has been at work, and has induced the living organism to respond in similar manner, no matter that the stocks were of different pedigree. But does that imply the inheritance of acquired characters? Even here more evidence about food and habits is necessary before any valid conclusion can be drawn.

So it is, unfortunately, with most of the observations adduced in support of particular means of evolutionary progress. Sir Edward Poulton mentioned the work of Weldon and Thompson on the influence of impurities in the sea at Plymouth upon the frontal width of the common shore crab, which, it was suggested, ensured that the water flowing over the respiratory surface was more efficiently filtered. But these observations and experiments, beautifully convincing as they appear to be at first sight, have been criticized so reasonably and ably that the conclusions cannot be accepted with any confidence.

The fact of the matter is that the story of evolutionary thought shows, as regards the processes of evolution, that the first flush of enthusiasm, with its easy evidences and somewhat uncritical observations, has passed, and that science will be satisfied only with careful record or controlled experiments safeguarded so as to convince the open but critical mind. To this new evidence the naturalist, as well as the experimenter, must make his contribution; but for the naturalist also the conditions become more stringent, and, to take another example, the statistical analysis in relation to protective patterns of food taken by a bat will be regarded as valid only when viewed in relation to the abundance of the food items and their availability at the time and place of the bat's collecting; and that is no simple series of observations.

In another way, investigation into the modes of evolutionary progress is likely to undergo modification. Few biologists, nowadays, doubt that natural selection has played a great part in guiding that progress; it is taken to be, as Bateson took it, self-evident. But natural selection merely plays with variations created by the organism; the vital problem lies deeper. Does the vitality of the organism, a thing of wondrous properties, really express itself in non-significant variations left entirely for Nature to carve into line, or does it respond more directly to the environment in such a way that subsequent generations share in the response, or does it even more directly handle its own fate by striking out in determinate lines of its own—it being postulated, of course, that whatever the source of the variations they must afterwards come under the pruning hook of natural selection? There seem to lie the evolutionary problems of the immediate future for the eager student of biology.

Ancient Fauna and Early Man at Bethlehem

THE report on the bone-bearing beds of Bethlehem by Miss E. W. Gardner and Miss D. M. A. Bate, appearing in this issue of NATURE (see p. 431), summarizes the results of three years' excavation on a site situated in the highest part of Bethlehem on the highest point of the Judean arch, of which the importance for the physiography and palæontology of Palestine was established in 1934 by the discovery of the fossil remains of an elephant, the first evidence of the former existence of this extinct species in this geographical region.

Since that date, as Miss Bate shows, the Bethlehem bone beds have yielded evidence of an extinct fossil fauna, which is not only almost entirely new to Palestine, but is also of earlier geological age than any found there hitherto. Further, from the gravels of these deposits have come 'flints', which may prove to be the earliest trace of man in Palestine.

The character of the geological deposits in which the fossil fauna occurs, as is indicated in Miss Gardner's report, is such as to add considerably to the importance of the discovery. The bones were found in water-borne gravels deposited on a cemented scree, or breccia, weathered subaerially. The lie of the deposits is such that it is evident that they cannot have been laid down originally in the position in which they are now found. While Miss Gardner exercises a wise discretion in refraining from any premature conjecture as to their origin before excavation is complete, she goes so far as to suggest that the condition of the deposits may be due either to the collapse of the original floor or to the filling of a funnel-shaped hole. These conditions are of prime importance in pointing to movement and physiographic changes, indicating a considerable antiquity.

While the evidence of geology, pending further investigation, is thus reticent as to questions of origin and chronology, the aid of other branches of investigation—archæology and palæontology—is invoked to give evidence on the question of dating; and here is brought forward what to many certainly will seem the most startling evidence from this investigation. Miss G. Caton-Thompson, whose experience in dealing with early Stone Age forms in the East entitles her to speak with authority, has found in the vast multiform assemblage of cherts in the gravels, showing evidence of subjection to a variety of forces, a number of pieces which she holds it difficult to explain except as humanly fashioned tools. Drawing a pregnant comparison with Mr. Reid Moir's 'artefacts' from the Red Crag of Foxhall and the sub-Crag detritus bed flints of Bramhall, she regards many of the Bethlehem 'artefacts' as conforming closely "in shape and edge trimming to the classic type of Harrisonian eolith". She goes on to point out that this is the first time such evidence has been found in a sealed deposit in Palestine—evidence which "is less easy reasonably to explain as the accidental work of natural forces, than as the deliberate experimental work of man in remote pre-Chellean times".

The archæological evidence, thus possibly the earliest indication of man's appearance in Palestine, gains in significance when brought into relation with the interpretation of the palæontological data, as regards geographical distribution and dating.

The crucial point is the occurrence of the diminutive form of horse, *Hipparion*, previously known from various deposits in Asia of Tertiary age, but recently reported from the Pleistocene of India, and now well known from the Pleistocene deposits of East Africa. With it goes the evidence of other members of the Bethlehem fauna, also pointing to an affinity with Asiatic forms of like age. Miss Bate, therefore, in summing up, concludes by suggesting that the Bethlehem fauna in origin is Asiatic and that its age is not later than early Pleistocene, adding that it provides a faunistic link for this period between Asia and East Africa.

It need scarcely be said that if Miss Caton-Thompson's tentative acceptance of the specimens she has selected as artefacts is well grounded, this discovery at Bethlehem will prove of transcendent importance in the consideration of the problem of the distribution of early man. It would be premature to enlarge on this aspect before the specimens have received further expert consideration; but it may be pointed out that these excavations serve to reassert the growing importance of Palestine for the problems of early man, already demonstrated in Miss Garrod's excavations and the investigations of Sir Arthur Keith and Mr. T. McCown on the physical characters of the early forms of man from Mount Carmel.

Scientific Aspect of Chinese Glazes

Chinese Ceramic Glazes
By A. L. Hetherington. (Courtauld Institute of Art.) Pp. x + 76 + 14 plates. (Cambridge: At the University Press, 1937.) 10*s*. 6*d*. net.

THIS concise and simply written treatise, which embodies an amplification of a series of lectures given recently by the author at the Courtauld Institute of Art, links together scientific facts and archæological knowledge concerning the chief glaze effects produced by Chinese potters during a period extending over some two thousand years.

A preliminary chapter is devoted to general considerations on the nature of the glazes, slips and earthenware bodies employed by successive generations of Chinese potters, on the effect of oxidation and reduction upon the colouring materials used in glazes, and on the modifications produced in these colour effects by the relative proportions of acidic and alkaline constituents in a glaze.

It is a striking testimony to the long-sustained art of the Chinese potter that nearly all his earlier colour effects were achieved by the use of only two metals, iron and copper. The old and fascinating 'iron' story, well exemplified by the ceramic ware shown at the Chinese Exhibition in London of 1935, explains the great variety of colour tints induced in glazes by varying amounts of the three iron oxides. Temperature conditions of firing and the presence of alkalis affect the final colour very appreciably. The pale blue ferrous oxide glaze of certain translucent porcelains dating from Sung times, on spectroscopic examination in the electric arc has shown persistent evidence of the lithium spectrum, a fact which points to the presence of lithia-mica in the original felspathic glaze (Chinese petuntse).

The range of colour produced by ferric oxide is even more extensive than of ferrous oxide, and, as the author has shown experimentally with boric acid and alkali borates, is greatly affected by the acidity or alkalinity of the glaze constituents.

The 'copper' story is equally remarkable, for the colour effects produced by cupric oxide and its reduction product, colloidal copper, are of the highest artistic merit. The author discusses in detail the scientific principles underlying the production of sang-de-bœuf, chün-yao, flambé and peach-bloom glazes, this section being illustrated by several coloured plates.

Under the heading of other glaze effects, a section is devoted to the use of cobalt, manganese and gold. The first two metals are utilized as colouring materials in the form of their oxides; whereas the *famille rose* wares owe their characteristic tints to the use of minute amounts of colloidal gold. This chapter contains also references to opalescence and to crackle, the latter effect being a special and popular feature of Chinese porcelain, which often develops on ageing a delayed crazing or double crackle.

This book, which contains fourteen plates, concludes appropriately with an informative glossary of Chinese and other technical ceramic terms. A selected bibliography is also included of works on Chinese ceramics, among which are to be noted two earlier publications by Mr. Hetherington on the porcelain factories and ceramic wares of China. To these authoritative treatises the present book forms a useful complementary volume.

G. T. MORGAN.

The Future of Statistical Mechanics

Statistical Mechanics:
the Theory of the Properties of Matter in Equilibrium. By Prof. R. H. Fowler. Second edition, revised and enlarged. Pp. x + 864. (Cambridge: At the University Press, 1936.) 50*s*. net.

PROF. R. H. FOWLER'S monumental work on statistical mechanics has, in this the second edition, in his own modest words, been rearranged and brought more up to date. But the new volume is much more than a revision, in that it is explicitly based on quantum mechanics from the outset; the first dynamical equation found written in the formal presentation is a wave-equation. Prof. Fowler states in justification that although classical mechanics is used to derive the quantum mechanics by a process of generalization, "once the laws of quantum mechanics have been thus guessed, as they must be before we can discuss the theorems of statistical mechanics, quantized systems naturally come first. In 1935 this attitude hardly needs apology". In consequence of this, the concluding chapter of the first edition, dealing with quantum statistics, has been incorporated in the new exposition from the start, and what is

effectively the opening chapter is now doubled in length. Otherwise there is no change of general structure. But a comparison of the two editions shows that the chapter of the first edition entitled "Thermionics" is now more than four times as long, and contains a treatment of the electron theory of metals and of semi-conductors ; that the chapter on dielectrics and magnetic constants has been similarly extended, and now includes an account of ferro-magnetism ; lastly, there is a new concluding chapter on "co-operative" and other phenomena. The number of references is almost doubled. It is difficult to over-estimate the amount of work involved in thus re-writing and extending what was already an encyclopædic work.

The fascinating introductory chapters raise a number of interesting questions in the mind of the reader. One is that of the physical origin of the extreme generality of statistical mechanics. It is a logical structure, based on certain laws of quantum dynamics which are themselves inductions from certain special sets of phenomena ; but, as Prof. Fowler remarks, the structure is "not visibly constructed to fit the facts", that is, the facts concerning phenomena in the domain of large numbers of interacting systems. "Results have been at each stage deduced from the general theory, and checked by comparison with experiment". But the comparisons with experiment are far more than a checking of the results. The comparisons with macroscopic thermodynamics do more than test the formulæ derived : they permit the *identification* of symbols introduced abstractly, as part of the mathematical apparatus, with entities known physically in a different guise. One example is the identification of the abstract symbol ϑ with the factor $e^{-1/kT}$, where kT is known physically from the more concrete dynamical theory of gases ; a second is the identification of a symbol with the thermodynamic entropy ; a third is the identification of a set of symbols with the thermodynamic partial potentials. The structure exists independently of these identifications : the identifications permit us to recognize the correspondence of the abstract scheme with Nature. Some of Gibbs's theorems in pure thermodynamics were known as logically unexceptionable results before the corresponding phenomena were fully studied. How comes it that statistical mechanics is in an even more powerful position ?

It is impossible to answer such a question in a review. But it may be recalled that a necessary, if not a sufficient, condition that a logically correct structure shall 'correspond' with Nature is that it shall also be epistemologically correct. There must exist some ground for our direct acquaintance with the entities introduced, in the sense used in the theory of knowledge. In some way, statistical mechanics must be, also, epistemologically 'sound'. Yet in the first dynamical equation used by Fowler, already mentioned, there occurs the symbol ψ, whose epistemological status is, to say the least, doubtful. This dynamical equation of motion is, however, preceded by a dynamical *statement*, concerning the structure of a Hamiltonian, based on classical mechanics, all the terms in which are assumed directly knowable by observation. The Hamiltonian, in this case that for an ideal linear oscillator, is the *definition* of an oscillator as required for the purposes of the theory. In other words, we make clear to the reader what we are talking about by tacitly supposing a correspondence between the crude physical picture of an oscillator and the terms in a mathematical expression. Out of such axiomatic definitions mathematical physics arises, but here there is a jump from the axiomatic definition to the associated wave-equation. In cruder forms statistical mechanics existed before wave-mechanics was known, though it still had to make certain appeals to a quantum theory. There would seem possibly to be scope for a treatment which is confined to the properties of assemblies of large numbers of systems and originates from axiomatic definitions concerning such alone.

Prof. Fowler mentions the well-known consideration that the fact that a particular mechanism leads to a state of complete equilibrium in agreement with experimental facts is no evidence for the particular mechanism discussed. It is merely evidence that the laws of the mechanism have been correctly and consistently written down. It follows that there *are* certain restrictions on the laws of the mechanism, for they might have been incorrectly written down. An example of such a restriction is the principle of detailed balancing. It would be interesting to know the complete set of restrictions which statistical mechanics imposes. Are they merely that the mechanism must obey the laws of dynamics assumed as a basis for statistical mechanics ? If not, how much less restrictive a dynamics is all that is necessary ?

Prof. Fowler takes a somewhat pessimistic view of the future of statistical mechanics when he writes that "developments in the near future seem likely to consist mainly of applications to more and more complicated models . . . designed to account for more and more subtle properties of matter in equilibrium". Two possible lines of development offer themselves, both suggested by remarks of the author himself. One is in the statistical mechanics of non-enclosed assemblies. Prof. Fowler writes : "All assemblies whose equilibrium states can be discussed are necessarily *enclosed* assemblies. An unenclosed assembly to which all space is accessible does not in general

possess an equilibrium state about which anything significant can be said". But is this true? It would be highly interesting to obtain theorems of statistical mechanics valid in an unenclosed finite space or in an expanding sphere of inaccessible boundary. The latter case would have the added charm that the number of systems that it would be necessary to consider would be truly infinite and not merely 'large'.

Again, the part of an assembly which for the greater part of time has practically an independent existence is called a *system*, and statistical mechanics is in part the study of the equilibrium states of assemblies of such quasi-independent systems. But the dynamics of a system, still more of an assembly, seems to be an aspect of the relation of such an assembly or system to the rest of the matter in the universe; the laws of dynamics are derivable from a study of such relationships. If so, in what sense are the systems 'independent'? They are formally independent *given the laws*, but not independent when the dynamical laws themselves are subject to examination. This gives one an uneasy feeling that the present status of statistical mechanics is uncertain, and that a thorough-going treatment would indeed contemplate at one blow the interactions of *all* the particles in the universe. Is it not possible that some features of the distribution of spiral nebulæ in the whole universe, their mean separations, masses and proper motions, could be studied by the methods of statistical mechanics?

The other line of development is the prol of steady states which are not equilibrium st Consider, for example, the one-dimensional of heat through a gaseous assembly mainta in a steady non-isothermal state by the imposi of plane boundaries kept at given une temperatures. The gas must settle down in steady state of maximum entropy subject to given boundary conditions. Such a non-equilibi steady-state is composed of independent syst interchanging energy, and indeed handing energy across each plane section at the same r If, therefore, the boundary conditions of g temperatures could be stated in molecular langu the whole problem could be treated as a maxin or average problem by the usual methods statistical mechanics. The trouble comes in in precise formulation of the boundary condition the two ends in kinetic language when they merely given in thermodynamic language. S we know that the whole phenomenon is a 'tr port' phenomenon, involving the sizes or paths of the systems, we cannot hope to solve problem without some discussion of mechan But the mechanism that is relevant is su mainly the mechanism of transfer at the two boundaries, and it is just because the prob suggests the hope of a statistical calculation thr ing light on mechanism that this problem is attractive. I believe the problem to be in tractable.

E. A. M

Plant Protection

The Scientific Principles of Plant Protection: with Special Reference to Chemical Control. By Dr. Hubert Martin. Pp. xii + 379. (London: Edward Arnold and Co., 1936.) 21*s*. net.

IN these days of selected races, artificial fertilizers and other specialized conditions, plants are proving alarmingly susceptible to attack, and there has in consequence grown up a technique regarding their protection and a science to correspond where mycologist and entomologist, chemist and physicist, meet on equal ground. 'Plant doctors' abound and there are numerous remedies varying from the spraying with copper preparations, which make the vineyards of the Rhine look so unnatural, to the use of other and beneficial insects to control the malevolent. The late Prof. H. E. Armstrong pictured for us the golfer salting his way over the greens with copper arsenate followed by the bodies of earthworms. Like Sir Albert Howard, he preached supreme value of good nutrition based on organic compost and believed that the outbre of disease are due to lack of organic manure; t in short, properly fed plants, like properly animals, would be largely resistant to disease the road to health is through organic protec foods.

Evidence is accumulating in favour of this v and it is one which plant growers cannot af to neglect in the future. In the meantime, farr fruitgrower and gardener have to face the rava of blights and pests on their new varieties of pla due in part to the fact that massing favours spreading of chance infection: it is a fact t the more intensive the cultivation the greater risks. Most of these were practically unknow few years ago and so there has been an urge find remedies to combat them. Dr. H. Martin Long Ashton, one of the most active and succes

horticultural research stations, has long been regarded as an expert on the subject and the present book is a second edition, though since it has been rewritten and reset, since every phase of the subject has developed during the intervening eight-year period, it may virtually be regarded as a new book.

It is a well-balanced production with the material arranged in logical order—plant resistance is in the foreground, the factors which make plants susceptible come next and then follow several chapters on biological control, fungicides and insecticides; weed killers, fumigants, seed and soil killers, complete the list, though Dr. Martin has also something to say about traps.

A goodly list of chemicals is paraded before our eyes, as numerous as the nostrums in the druggist's shop, and it is no wonder, in the words of Sir Daniel Hall, that "great commercial firms have embarked upon the manufacture of suitable materials for sprays and washes and have themselves promoted investigation in their desire to produce useful remedial preparations".

At the foot of the plants is the soil, which receives more than its share of the remedies, with an effect on its own fauna and flora which can only be imagined. The worms certainly object, but to-day Darwin's famous book on earthworms is out of date, and probably green-keepers do not read it.

The fact that the other side of the picture has been emphasized here must in no way be allowed to detract from the excellence of Dr. Martin's book or the economic importance of the application of the methods he describes. E. F. A.

Gases and Metals

Gases and Metals: an Introduction to the Study of Gas-Metal Equilibria. By Dr. Colin J. Smithells. Pp. vii + 218 + 4 plates. (London: Chapman and Hall, Ltd., 1937.) 18*s*. net.

THE behaviour of metals towards the common gases is important to many industries, but investigators who have been concerned with its various aspects have had little contact with each other, and the subject has not hitherto been adequately treated from a theoretical point of view. Dr. Smithells's book is therefore extremely welcome, and its wide scope and original outlook make it a most valuable addition to metallurgical literature.

The work is divided into three chapters, which deal respectively with the adsorption of gases on the surface of metals, the diffusion of gases through metals, and their solution in metals. In each chapter there is a short general introduction and a brief description of the experimental methods, followed by a comprehensive survey of the most reliable results. No emphasis is placed on technical considerations, the data being discussed with the single purpose of defining the general laws which are obeyed, with the view of gaining an insight into the physical nature of the processes.

A sharp distinction is made between physical adsorption, which depends on van der Waals's forces alone, and activated adsorption, in which binding forces of a stronger nature are involved. Much importance is attached to the observation that only those gases which undergo activated adsorption by a given metal can dissolve in and diffuse through it, from which it is concluded that activated adsorption is a necessary preliminary to diffusion and solution, and that for all these processes some degree of chemical affinity between the gas and the metal is necessary. This thesis is elaborated in the second chapter, which contains the results of the author's and Ransley's work on diffusion, and is the most vigorous and satisfying part of the book.

In the section dealing with solution, ample recognition is given to the work of Sieverts and his collaborators, and the absorption of hydrogen by palladium, which bulks so disproportionately in the literature, is relegated to its proper place as a somewhat unusual borderline case.

This chapter contains a most valuable collection of data, but more is known of the relations between compound gases and metals than appears in this account, and the ferrous metallurgist, in particular, will feel that the equilibria which control the refining of molten steel, and its carburization or decarburization in the solid state, have received less attention than they deserve. Yet in the present state of knowledge, these relations could not have been described in the comprehensive style accorded to the rest of the book. If the metallurgist finds that reactions between compound gases and metals have not been considered as fully as their practical importance would lead him to expect, the omission will come as a salutary reminder that the experimental work which would render a satisfactory treatment possible has, for the most part, not yet been done.

N. P. A.

La civilisation Aïnou et les cultures arctiques
Par Prof. George Montandon. (Bibliothèque scientifique.) Pp. 272+48 plates. (Paris: Payot et Cie., 1937.) 40 francs.

PROF. MONTANDON visited the Ainu of Yezo, or Hokkaïdo as the Japanese now term it, in 1919. On his return he brought back a great stock of observations and an ethnographical collection, now housed in the Trocadéro in Paris, which one of the foremost authorities on the Ainu at that time pronounced to be the most complete that had ever left the island. In publishing the results of his observations in a volume which appeared not long after, Prof. Montandon promised that a more extended study of Ainu civilization would follow. This promise is fulfilled in the present volume, in which the author has reviewed and analysed critically in the light of his own observation all the information available relating to the culture of this primitive and isolated outpost of the white race.

The study falls into two parts. In the first part, Ainu civilization is described in detail as a unitary manifestation of cultural development. In the second part it is brought into relation with the cultures of the various peoples of northern Asia—Yakut, Yukagir, Gilyak, Eskimo, etc.—and as a result of an analysis of the distribution of cultural traits, an attempt is made to arrive at an estimate of the character of the original Ainu culture. As might be expected, Prof. Montandon's conclusion is that everything in Ainu civilization which can be assigned to an Ainu origin is of extremely primitive character, and belongs to the stage of the food-gatherer and the primitive hunter and fisher. All else is of extraneous origin; this, perhaps, might throw light on the remarkable distribution of the Ainu blood groups, which in its combination of mixed characters Prof. Montandon finds disconcerting.

Prof. Montandon's work is a valuable contribution to the critical literature of ethnology, as well as a welcome survey and record of a civilization which in recent years has suffered much change.

The Development of Modern Medicine:
an Interpretation of the Social and Scientific Factors Involved. By Prof. R. H. Shryock. Pp. xv+442+8 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1936.) 18*s*. net.

THE object of this fascinating work, the author of which is professor of history at Duke University (Carolina), is to portray certain major aspects of medical development against a background of intellectual and social history in general from the commencement of the seventeenth century down to the present time. In the eighteenth century it is shown that physic at first did not keep pace with physics, and it was not until the latter part of this century and the beginning of the nineteenth that medicine began to make further progress. An important step in advance was the successful attempt to correlate clinical and post-mortem observations, in which Boerhaave, Haller and most of all Morgagni were pioneers. The second half of the eighteenth century was notable for contributions made to public health such as the establishment of hospitals and dispensaries, child welfare, the control of drunkenness, work on naval and military hygiene, vaccination and other sanitary reforms.

Among the more important advances in modern times stress is laid on the collection of statistics, the influence of French medicine in Europe and the United States, medicine in Germany, preventive medicine and the economic aspects of medical practice.

Materie und Strahlung (Korpuskel und Feld)
Von Prof. Dr. Ludwig Hopf. (Verständliche Wissenschaft, Band 30.) Pp. viii+162. (Berlin: Julius Springer, 1936.) 4.80 gold marks.

IN some respects, this is a remarkable little book. The preface warns the reader that it is more difficult to present a tolerable account of modern physics without mathematics than with them: furthermore he must not expect easy going. The theme throughout is the 'field' and corpuscular aspects of matter and, very properly, this leads up to a climax in the more recent attempts at a synthesis by Heisenberg and by those concerned with electron waves.

The author's treatment is naturally at its best in the earlier chapters dealing with classical physics. Here, the use which is made of diagrammatic representation appears to great advantage, especially for the gas laws, Brownian movement and electromagnetism. In quantum physics and wave mechanics, wherein direct appeal to the eye is scarcely possible, the method is perhaps not quite so happy, since the writer depends to a great extent upon direct illustration.

The philosophical outlook is characteristic and stimulating; it is woven into the fabric of the book with considerable skill. Altogether, this is a type of contribution to the literature of physics seldom seen in Great Britain, and on that account alone well worthy of careful study. F. I. G. R.

Die medizinisch-naturphilosophischen Aphorismen und Kommentare des Magister Urso Salernitanus
Nach Handschriften Lateinisch und Deutsch herausgegeben von Rudolf Creutz. (Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin, Band 5, Heft 1.) Pp. 192. (Berlin: Julius Springer, 1936.) 26.60 gold marks.

IN addition to an introduction by Dr. Paul Diepgen, professor of the history of medicine in the University of Berlin, this volume contains the aphorisms on medicine and natural philosophy of the thirteenth century physician and ecclesiastic Urso of Salerno, otherwise known as Magister Orso, followed by his commentaries in the Latin text. Dr. Rudolf Creutz has provided a full German translation of the aphorisms and an abbreviated translation of the commentaries. The historical significance of Urso, as Prof. Diepgen points out, lies in the fact that he deals with the same problems as Arnold of Villanova in the fourteenth, and Paracelsus in the sixteenth centuries. All three writers were penetrated with Platonic and neo-Platonic ideas and reconciled their religious views with their outlook on natural science

Observational Evidence for the Distribution of Matter in Space

By J. H. Reynolds

IT is often found necessary by mathematical physicists to make some generalized assumption which in detail is obviously not in accord with experience and observation. This procedure is, of course, quite legitimate, and much important work has been done with such an assumption implicit throughout ; and so long as it is recognized that it is still no more than this when the mathematical work is done, no exception can be taken. But when a mathematical assumption is brought down from its idealized condition to a pedestrian 'fact of observation', it is time for the 'fact of observation' to be put through its paces.

Such has happened quite recently in the columns of NATURE to the assumption that matter is uniformly distributed throughout space. It is a very desirable condition for the mathematical physicist to postulate, as it is impossible to work with an irregular distribution ; and within the limits mentioned, it has been made the basis of some very interesting and far-reaching researches. But it is now stated that it is an observed 'fact', based on the equable distribution of the 'spiral' nebulæ in space, and it is this statement which requires verification.

Fortunately, the observational material which is now available is sufficiently complete and homogeneous for us to form definite conclusions as to the spatial distribution of the spiral nebulæ, and those of the same class which show no spiral form and are known as elliptical and irregular nebulæ. This observational material, however, is limited to something over a thousand objects, and comes to an end at some distance roughly corresponding to 13×10^6 light years. Beyond this limit it is neither complete nor homogeneous, and it has only been possible to investigate selected regions photographed with the great American reflectors.

There are two criteria which can be adopted for estimating the distances of the nearer extragalactic nebulæ—the angular diameters and the integrated magnitude of luminosity. Both are subject to a considerable degree of uncertainty, for there is known to be a large spread in linear dimensions and in integrated brightness. This is apparent in the nearest two spiral systems, the Andromeda Nebula and *M*33. The first is condensed into stars in the outer regions with a patchy background of hazy nebulosity, the inner parts consisting of bright nebulosity increasing greatly in luminosity to a star-like central nucleus. The diameter of the major axis of the apparent ellipse on reflector plates is 160′. *M*33, on the other hand, is much more stellar in general composition and only the central regions are nebulous, with little increase of brightness in the nucleus. The major axis is 65′ on reflector plates. (The angular dimensions are those measured visually on negatives exposed in large reflecting telescopes. It has been found that these dimensions are considerably increased if recording microphotometers are used. The excess usually consists of very faint and featureless nebulosity.)

From the criterion of the Cepheid variables found in the outer regions, the distances of both can be estimated with reasonable certainty at between 700,000 and 800,000 light years (about 240 kiloparsecs) in each case, although the diameter of the Andromeda Nebula is two and a half times that of *M*33.

The difference between the integrated magnitudes of the two systems is still more striking. According to a list of extra-galactic nebulæ by Shapley and Ames (*Harvard Coll. Ann.*, 88, No. 2), the integrated magnitude of the Andromeda Nebula (*M*31) is about 5, *M*33 being 8. The ratio between one magnitude and the next being 2·512, *M*31 as a whole is sixteen times as bright as *M*33. But even this relative luminosity seems to be an understatement, for in a recent paper by Redman and Shirley (*Mon. Not. Roy. Ast. Soc.*, 97, 416) the integrated luminosity of *M*31 is given as 3·5 mag. (photographic), while the surface brightness at the centre is at least 14·8 mag. per square second of arc, compared with the fainter 20·3 mag. per square second of arc at the centre of *M*33. The dispersion in absolute magnitude can therefore be much greater than the dispersion in linear dimensions, judging from these two systems at about the same distance. For this reason I have preferred the criterion of angular diameter in my work on the spatial galactic distribution of the nearer systems.

In this kind of research there can only be one division of the celestial sphere which is fundamental, namely, that in which the great circle of the galaxy forms the equator, and all investigations into the distribution of the extragalactic nebulæ have been based on this. Let us take first of all the extragalactic systems which lie within a radius of 700 kiloparsecs ($2{\cdot}275 \times 10^6$ light years).

If we include the two Magellanic Clouds and the irregular nebula N.G.C. 6822, we find within this radius nine systems are in the south galactic hemisphere against four in the north. This result is based on Cepheid variables in the nearer objects and the detection in the more distant nebulæ of faint stars which Hubble assumes cannot exceed −6 absolute magnitude : in the case of N.G.C. 55, 247 and 300, photographed at the Helwân Observatory, Egypt, the distances are based on large angular diameters only. Seven of the nine southern systems are also probably nearer the galactic system than any of the four northern objects.

Past a radius of 1,000 kiloparsecs ($3{\cdot}25 \times 10^6$ light years) the large preponderance of systems passes to the north galactic hemisphere. They are now so far distant that no stars can be detected even with the 100-inch reflector at Mt. Wilson ; the criterion of integrated luminosity has therefore been adopted both in Hubble's work and in Shapley's investigations at the Harvard College Observatory. The luminosity ratio between one magnitude and the next being 2·512 ; this represents a difference in distance of 1·585 per magnitude.

It is to Shapley and Ames that we owe the most complete and reliable evidence as to the galactic distribution. The whole sky was photographed with two 2-inch lenses at centres regularly spaced, the scale of the plates being 10 minutes of arc to the millimetre, and the magnitude limit for 90 minutes exposure lying between 13·5 and 14·0. The small scale brought the linear size of the nebulæ on the plate down to something near that of star disks, which could be directly compared with stars of known magnitude. It was assumed that the plates gave essentially complete information as to the nebulæ brighter than 13·2 magnitude, and this information was comprised in a detailed catalogue of 1,249 objects. It was further assumed that all these were included within a radius of 3,000 kiloparsecs ; this estimate was based on integrated magnitudes alone, but if recorded angular diameters of the spiral class are taken as a criterion of distance instead, it would appear that this estimate would have to be increased to at least 4,000 kiloparsecs.

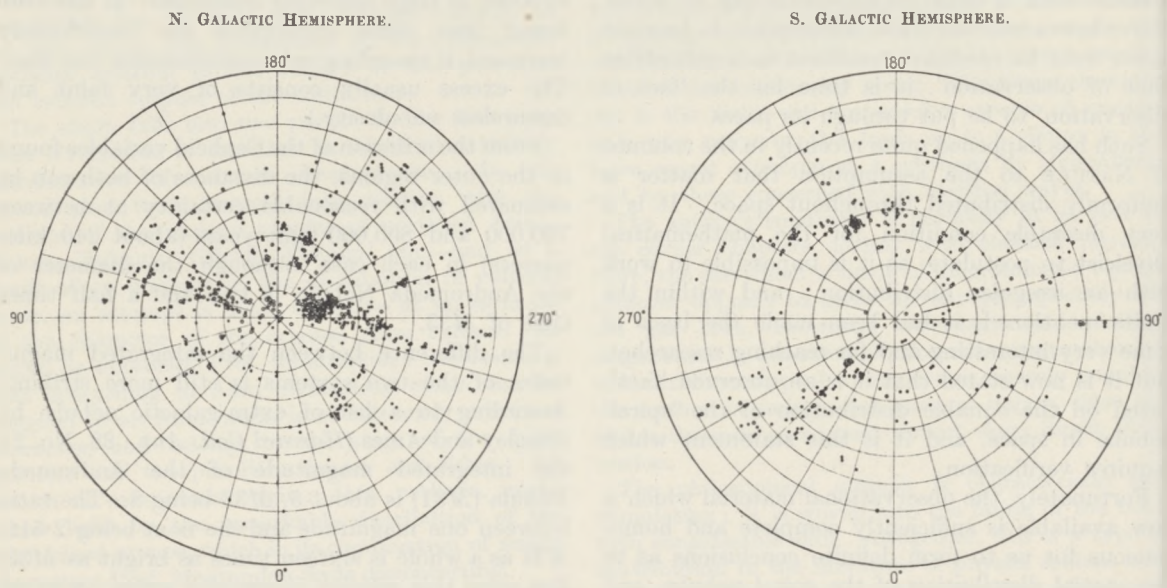

Fig. 1.

Distribution of the brighter extra-galactic nebulæ in the north and south galactic hemispheres. Open circles represent the 291 nebulæ brighter than photographic mag. 12 ; dots represent the 734 nebulæ of photographic magnitude 12–13. From *Harvard College Annals*, **88**, No. 2 (1932).

The plates included those nebulæ of large angular diameter above 10′ which lie within 1,000 kiloparsecs and have already been dealt with, and when all the nebulæ brighter than mag. 13 were plotted in the two galactic hemispheres it was found that those in the northern hemisphere were just about double the number of those in the southern. Not only so, but also the effect of longitude found in previous investigations without such complete information was fully confirmed. The diagram here reproduced (Fig. 1) is from Shapley's paper and includes 1,025 nebulæ down to mag. 13.

The great condensation in and towards the Virgo region between galactic longitudes 250° and 270° and its prolongation beyond the north galactic pole has been known for many years, and the irregularities in the south galactic hemisphere are

also marked. The lack of extragalactic systems within 10° of the galactic equator in both hemispheres is well accounted for by the known existence of vast clouds of obscuring matter in the galaxy. This corresponds to the 'belt of avoidance', the limits of which have been investigated by Hubble over three quarters of the great circle. In some parts the limits of the 'belt of avoidance' approach within a few degrees of the great circle, and faint small nebulæ have been photographed in these regions : in other longitudes the limits reach much farther away, and in some parts extend so far as 30°.

The evidence for the whole sky is therefore not complete by something like a fifth, although there is no reason to think that this missing fraction would seriously affect the results.

The distribution of some of the fainter and therefore presumably much more distant nebulæ was investigated by Hubble in 1934 (*Mt. Wilson Cont.*, No. 485). He eliminated the brighter ones which are included in Shapley's catalogue, and the material consisted of about 44,000 nebulæ distributed over three quarters of the sky north of − 30° Dec. Almost all these are very faint, with a limiting magnitude of 20. A similar piece of work was undertaken about the same time from plates obtained by the Crossley reflector of 36 inches diameter, on which 15,000 small nebulæ were counted up to mag. 19. In neither case was the south circumpolar region represented between − 30° and − 90°, and the plates examined covered only about 2 per cent of the total area available, each plate being taken as a sample of the distribution in that particular region, and covering presumably, in the case of the 100-inch reflector at Mt. Wilson, about a quarter of a square degree of good definition. At the Lick Observatory, the scale of the 36-inch reflector plates was much smaller owing to the shorter focal length, and so covered about three times as much ; here 489 plates were examined. The frequency curve of successive photographic magnitudes (Nm) was computed on the assumption that the numbers increased according to an equable distribution of the nebulæ in space. Hubble found that the observed frequency curve of log Nm closely approximated a Gaussian error curve, which would agree with the assumption of equable distribution, if a reasonable dispersion in magnitudes with distance was allowed.

Bok in 1934 again investigated the question, using Hubble's observational material. He calculated the form of the frequency function for the number of systems per unit area of the sky, on the assumption that they are distributed at random. Hubble's observed frequency curve was then compared with the curve of calculated random distribution after ample allowance for dispersion in the limiting magnitudes had been made, and Bok came to the conclusion that this brings out very clearly that the distribution of the faint and distant systems is also not at random. He therefore agrees with Shapley that the general distribution is not homogeneous, and that the tendency to clustering is one of the chief characteristics of the extragalactic universe, so far as we have been able to plumb its depths.

There seems to be little doubt, therefore, that while the uniform distribution is a useful assumption of mathematical necessity, it is certainly not a 'fact of observation'. The evidence of the nearer systems within a radius of 4,000 kiloparsecs is directly contrary to the assumption, while beyond this limit the evidence is quite insufficient to arrive at a definite conclusion in its favour.

The Nutritive Value of Pasteurized Milk

MUCH controversy has arisen over the question whether the bulk of milk sold in Great Britain should be pasteurized or not. There is no doubt that many epidemics have been caused by the consumption of raw milk, which there is presumptive evidence would not have taken place if the infecting bacteria had been destroyed by pasteurization before the milk reached the consumer. On the other hand, experimental evidence has been brought forward to show that the nutritive value of milk is impaired by pasteurization, although in other experiments no significant change in nutritive value could be demonstrated.

The problem is that of producing a 'safe' milk at an economic price ; up to the present, the average consumer has refused to pay the higher price of milk obtained from disease-free cows and produced under conditions reducing the risks of contamination to a minimum. However, even under the best conditions, there is always the risk of a worker suffering from an infectious disease contaminating the milk he is handling and so spreading the disease over a wide area, so that adequate heat treatment of the milk may prove the only safeguard, but this can only be recommended with confidence if the nutritive value is not impaired

by the heating process, or only impaired in a manner which can easily be remedied.

Towards the end of 1934, an informal conference was called by the Milk Marketing Board's Advisory Committee on Milk Publicity, at which representatives of Government Departments, the Medical Research Council and the Milk Marketing Boards were present: the object of the conference was to consider what further investigations were required on the nutritive value of milk. The conference entrusted the task of conducting these investigations to a special committee—the Milk Nutrition Committee—of which the first report, dealing with the results of work on rats and the direct chemical estimation of vitamin potency, has recently been published*. Investigations in schools and with calves will be reported in the near future.

The greater part of the work described in this report has been carried out by Dr. S. K. Kon and his colleagues at the National Institute for Research in Dairying, Shinfield, near Reading: the experiment on the availability of the calcium and phosphorus of pasteurized milk was duplicated at the Rowett Research Institute, Bucksburn, by Dr. D. W. Auchinachie. The same general plan was followed in all the experiments: the samples of raw milk were drawn from the tip tank of the pasteurizing plant after careful mixing, and those of the pasteurized milk were taken after cooling when about half the vat had been emptied. The pasteurization was carried out under commercial conditions by Messrs. Emerson and Chanin, Reading, or at the headquarters of the Aberdeen Milk Pool. The temperature of pasteurization was frequently checked and bacteriological and phosphatase tests were carried out on the milks; in addition, daily estimations of fat and total solids were made during part of the experimental period. The milks were compared as sources of calcium and phosphorus, protein and vitamin B in experiments on rats, and as sources of vitamin A and carotene and vitamin C by chemical tests. The results of these experiments can be quite briefly summarized: pasteurized milk is as good a nutritive agent as raw milk, except in the case of vitamin B_1 and vitamin C.

Since the results of these experiments are of considerable importance, it may be advisable to describe them in more detail, especially as the assessment of the value of the evidence adduced must depend ultimately on the investigators' attention to detail. For the determination of the availability of the calcium and phosphorus in the milks, a complete metabolism experiment was carried out, Kon employing two dozen animals and Auchinachie a dozen. The animals were housed in metabolism cages, in which the excreta could be collected, and the feeding dishes were designed to prevent any scattering of the food. The rats were grouped in pairs according to sex and litter and the amount of basal diet offered was slightly in excess of that consumed by the animal with the smaller appetite; one animal received raw milk and the other the same amount of pasteurized milk. The basal diet consisted of dried eggwhite, calcium- and phosphorus-free salt mixture, casto sugar, maize starch and butter fat, with supplements of cod liver oil and vitamin B_1 extract. The quantity of milk supplied daily was calculated to supply about 60 per cent and 70 per cent of the normal requirements of calcium and phosphorus respectively. The experiment was continued for five weeks: the deposition of calcium and phosphorus in the tissues of the animals was determined by two entirely independent methods. In the first the retention was found from the total intake of these elements in the food and milk and the amounts excreted in the urine and fæces. In the second, the retention was estimated from the amounts present in the bodies of the animals at the end and at the beginning of the experiment; the latter figures were obtained by analyses of a similar number of litter mate controls of the same sex as the experimental animals, killed at the beginning of the experiment. For pooled figures the two methods agreed within 0·2 per cent in the case of calcium and 2·0 per cent in the case of phosphorus; the slight discrepancy in the case of phosphorus was probably caused by a small loss during ashing of the rats. The agreement between the two methods indicates that the metabolism experiment had been carried out satisfactorily.

It was found that the animals retained some 80 per cent of the ingested calcium and phosphorus irrespective of the type of milk given. Statistical treatment of the results showed that pasteurization had no deleterious effects upon the availability of these elements. The only statistically significant differences were a retention by the does of pasteurized milk of 3 per cent more calcium than their litter mates on raw milk and a greater increase in weight of the bucks on raw milk. In all the rats about 90 per cent of the calcium excreted was found in the urine and about 90 per cent of the phosphorus in the fæces; the reason for the high excretion of calcium in the urine, which is unusual, was not determined.

There was a similar failure to detect any difference between raw and pasteurized milk when the biological value and digestibility of the proteins and the total nutritive values of the milk

* Milk and Nutrition: New Experiments reported to the Milk Nutrition Committee. Part 1: The Effect of Commercial Pasteurization on the Nutritive Value of Milk, as determined by Laboratory Experiment. (From the National Institute for Research in Dairying (University of Reading) and the Rowett Research Institute, Bucksburn, Aberdeen.) Pp. 67. (Reading: National Institute for Research in Dairying, Shinfield, 1937.) 2*s*. 6*d*. net.

were compared in experiments on rats. In the latter experiments, the milk was the only food supplied, but was supplemented by the addition of small amounts of iron, copper and manganese: the manganese was shown to be an essential element for growth. Similar experiments on the value of the milks as sources of the vitamin B complex disclosed, however, that pasteurized milk was a significantly less satisfactory source than raw milk: the difference was, however, observed only in the case of the more rapidly growing bucks. The deficient diet used was supplemented by 8 ml. milk daily, an amount which was known to be sufficient for subnormal growth only. This difference between the milks was not seen when larger amounts were given daily, as in the experiments on their total nutritive value, or when the animals grew more slowly, as in the case of the does. The difference might, however, be disclosed during lactation, when the requirements for vitamin B are much greater.

The vitamin A and carotene contents of the milks were determined spectrophotometrically and by the tintometer, on butters churned from both types of milk over a period of five weeks. No destruction of vitamin A or carotene by pasteurization was found. The vitamin C content was determined chemically, by titration with the indophenol reagent, both before and after reduction of the milks with hydrogen sulphide: both the reduced and the reversibly oxidized forms of ascorbic acid showed loss on pasteurization, the loss being greater in the case of the latter. The total loss was about 20 per cent. Milk taken directly from the udder without exposure to light contains only the reduced form of ascorbic acid and can be pasteurized without loss of the vitamin by the holder method, in the absence of copper: the reversibly oxidized form of ascorbic acid is formed by the action of light upon the milk and is affected by pasteurization.*

To sum up, pasteurized milk may contain less vitamin B (presumably B_1) and vitamin C than raw milk, but will in other respects have the same nutritive value. Where milk is not the sole diet, such losses will have no significance, provided the diet also contains cereals and fruit. Where milk is the sole diet, a supplement of fruit juice and a yeast extract or other rich source of vitamin B_1 should obviate any possibility of the diet being inadequate in these respects, although, with a proper intake, the lower content of pasteurized milk in vitamin B is unlikely to be detected and it is now usual to supplement the milk with fruit juice (together with vitamins A and D, in the form of cod liver oil or a concentrated preparation of these vitamins). These experiments suggest that there need be no fear of malnutrition from the universal use of pasteurized milk; admittedly the risk of infectious disease will be considerably reduced.

* Kon, S. K., and Watson, M. B., *Biochem. J.*, **30**, 2273 (1936).

Bicentenary of Galvani

TEN years ago all Italy joined in honouring the memory of Volta on the centenary of his death; now arrangements are being made at Bologna to commemorate the bicentenary of the birth of his fellow countryman, Galvani, whose discoveries paved the way for those of Volta and led to the invention of the voltaic pile. Though the Galvani celebrations will not be on the same scale as those of ten years ago, they will help to recall the fundamental work done in Italy on current electricity which has had such fruitful results.

Aloisii Galvani was born in Bologna on September 9, 1737, and was thus about eight years older than Volta. After a youth in which theology and mysticism played a part, he settled down to the study of medicine, and in 1762, after writing a thesis "On the Bones, their Nature, and their Formation", was made a lecturer in the University of Bologna and reader in anatomy to the institute of the city. He was successful both as a teacher and a surgeon and became known for his researches in comparative anatomy. It was as an anatomist and physiologist, and not as a physicist, that he made the experiments which have immortalized his name.

The work for which Galvani is remembered was done during the years 1780–91. At least as early as 1780, he began observing the effects on muscular contractions caused by the use of the electrical machine, the Leyden jar and Volta's electrophorus. In 1782 he drew up a paper entitled "On the Nervous Force and its Relation to Electricity". His experiments were made on frogs in particular. Assisted by his nephew, Camillo Galvani, in 1786 he began observations on partly dissected frogs which had been suspended by hooks from the iron rails of the balcony of his house. These he first described in a paper "Esperimenti circa l'Eletricità dei Metalli", and in a Latin dissertation of 62 pages dated October 30, 1786, afterwards to form the most important part

of his work of 1791. Galvani was in doubt as to how to explain the effects he observed, and, said J. D. Forbes, who had carefully studied his writings, "in the short space of a few weeks, he had abandoned his earlier notion of the metals being the source of the electricity, and ascribed the effects to the proper electricity of the nerves and muscles". Still pursuing his experiments at intervals, in 1791 he published his most famous, and now very rare, memoir, "De Viribus Electricitats in Motiv Musculari Commentarius", the appearance of which roused great interest in scientific circles.

The first German accounts of Galvani's views were published in 1792 by a young doctor, E. J. Schmuck, and in October of that year Volta wrote his two letters to Cavallo entitled, "Account of some Discoveries made by Mr. Galvani of Bologna, with Experiments and Observations on them". The letters were in French, the first sentence being, "Le sujet des découvertes et des recherches, dont je vais vous entretenir, Monsieur, est l'electricité animale". Volta had sent the letters to be read to the Royal Society as an acknowledgement of his election as a foreign member in 1791. They were read at a meeting of the Society on January 31, 1793, and were duly published in the *Philosophical Transactions*. In 1794, when Volta was awarded the Copley Medal, Sir Joseph Banks in his address said :

"The experiments of Professor Galvani, until commented upon by Professor Volta, had too much astonished, and, perhaps, in some degree, perplexed many of the learned in various parts of Europe. To Professor Volta was reserved the merit of bringing his countryman's experiments to the test of sound reasoning and accurate investigation. He has explained them to Dr. Galvani himself and to the whole of Europe, with infinite acuteness of judgment and solidity of argument; and through the medium of the *Philosophical Transactions* he has taught us that the various phenomena which presented themselves under the modifications of Dr. Galvani's experiments hitherto tried, are wholly owing to the excessive irritability of the nerves when subjected to the action of portions of the electric fluid, too minute to be discovered, even by the delicate electrometer of our ingenious brother, Mr. Bennet, of Wirksworth ; and he has detected in the metals, which Dr. Galvani considered as mere agents in conducting his animal electricity, that very existing principle which the Doctor and his followers had overlooked."

Forbes considered the award of the Copley Medal to Volta, rather than to Galvani, a questionable decision, for "the great value of Volta's paper, at the time, was undoubtedly that it directed the attention of English experimenters to Galvani's discoveries, then quite recent and probably imperfectly known". That Galvani was little known and had not travelled, while Volta was personally known in both Paris and London, may have had something to do with the decision.

From 1791 onwards, Galvani did little more to add to his fame. His wife died, his health declined, and when after the French Revolution the Cisalpine Republic was set up, he declined to take the oath of allegiance to the new authorities and was dismissed from his offices. He died on December 4, 1798, apparently at the house of a brother to which he had retired after his dismissal. His writings were republished in one volume in 1841 by the Academy of Sciences of Bologna.

As regards the oft-repeated story of Galvani's observations on frogs being connected with the preparation of a dish for his invalid wife, Forbes dismisses it as an absurd invention.

Obituary Notices

Prof. D. Morgan Lewis

DAVID MORGAN LEWIS, emeritus professor of physics in the University of Wales, died at Aberystwyth on July 28, aged eighty-five years.

Born at Eglwyswrw, Pembrokeshire, in 1851, he was the eldest son of the Rev. Evan Lewis, minister of the Welsh Independent Church at Brynberian and a prominent figure in his denomination. His early education was received at a local British school and at Cardigan, and later he entered the Presbyterian College, Carmarthen, to train for the ministry. Here he became proficient in mathematics and in 1873 entered Trinity College, Cambridge, where he was 20th Wrangler in 1877. Afterwards he studied physics at the Cavendish Laboratory.

In 1878 Lewis was ordained as minister of the English Congregational Church at Hirwain, Glam., where he served until 1883. The advent of the new Welsh national colleges decided him to seek a wider field and in the latter year he resigned his pastorate and returned to work at the Cavendish Laboratory. In 1884 he was appointed as assistant to Andrew Gray, professor of physics in the new University College of North Wales at Bangor, with whom he worked in full accord until 1891, when he was appointed to the professorship at Aberystwyth in

succession to D. E. Jones. Here he worked quietly, and gradually built up an efficient department of physics until his retirement in 1919. He was married in 1894 to Miss Annie Powell of Carreg Cennen, Carms., who predeceased him in 1932.

Prof. Lewis was of a modest and retiring disposition, and greatly disliked publicity. Yet he could be very enthusiastic in those causes which, in his opinion, mattered. While at Hirwain he inaugurated and lectured to classes under the Science and Art Department, and later wrote considerably to the Welsh local Press to stress the importance of scientific and technical education in the new secondary schools which were then being established. He served the University Colleges of Bangor and Aberystwyth and the University of Wales well during their formative years, and the cause of adult education in the Principality found in him a willing helper. During many years, he served as a governor of Aberystwyth County School and was for a period chairman.

After his retirement, Lewis's main interests were in the affairs of his religious denomination, in Welsh hymnology and in archæology. Until quite recently, his quiet, dignified figure could always be seen at the meetings of the British Association, among whose members he had a host of friends. T. C. J.

DR. PERCY PHILLIPS, director of the Hydrological Service of the Physical Department, Egyptian Ministry of Public Works, died in Cairo on August 4, at the age of fifty-seven years. Previous to the Great War, he was a lecturer in physics in the University of London and during the War had a commission in the Sound-Ranging Section of the Royal Engineers, with which he saw service in France and Palestine. He joined the Egyptian Government Service in 1919, and was responsible for the collection and discussion of statistics relating to the water supply of the Nile. He did valuable work in the study of the hydrology of the Nile Basin and in the preparation of the large irrigation projects on the Nile.

WE regret to announce the following deaths:

Dr. G. P. Clinton, formerly botanist of the Connecticut Agricultural Experiment Station, known for his work in mycology, on August 13, aged seventy-one years.

Prof. F. B. Loomis, professor of geology in Amherst College, Mass., an authority on vertebrate palæontology, on July 24, aged sixty-three years.

Mr. Andrew Mellon, founder of the Mellon Institute of Industrial Research at Pittsburgh, Pa., sometime American Ambassador in Great Britain, on August 26, aged eighty-two years.

Prof. Luigi Pernier, professor of archæology and the history of ancient art in the University of Florence.

Lord Rothschild, F.R.S., a trustee of the British Museum and founder of the Tring Zoological Museum, on August 27, aged sixty-nine years.

News and Views

Sir Thomas Grainger Stewart (1837-1900)

SIR THOMAS GRAINGER STEWART, the eminent Scotch physician, who died on February 3, 1900, was born at Edinburgh on September 3, 1837. He qualified in 1858, and then visited the medical centres on the Continent, where he came in contact with Virchow, Schönlein and Traube in Berlin, and Oppolzer, Skoda and Hebra in Vienna. On his return to Edinburgh, he was made physician to the university wards in the Royal Infirmary. In 1876 he was appointed professor of physic and proved an exceptionally gifted teacher. He was one of the first in Great Britain to direct attention to the deep reflexes, and under the title of "Paralysis of the Hands and Feet from Diseases of the Nerves", he first described the condition known as multiple neuritis. For many years he held a foremost position as a consultant throughout Scotland and the north of England. His chief publications were "A Practical Treatise on Bright's Diseases of the Kidneys" (1868), "The Teaching of Medicine in Edinburgh" (1877) and "An Introduction to Diseases of the Nervous System" (1884). He was the recipient of many honours. In 1882 he was appointed physician to the Queen in Scotland, in 1887 he was made M.D. *honoris causa* of the Royal University of Ireland, in 1890 he was elected president of the Royal College of Physicians of Edinburgh and honorary fellow of the College of Physicians of Philadelphia, in 1894 he was knighted, and in 1898 he was elected president of the British Medical Association when the annual meeting was held in Edinburgh.

Samuel Siegfried Karl von Basch (1837-1905)

THIS eminent Austrian physiologist and physician was born on September 9, 1837, at Prague. After studying medicine in his native town and Vienna, he qualified in 1862 in Vienna, where he acted as assistant for several years to Dittel, Jaeger, Turk and Kalisko. In 1865 he went to Mexico, where he was appointed Court physician to the Emperor Maximilian, who was shot on June 19, 1867, and himself narrowly escaped execution. After his return to Vienna he carried out some important experiments on the action of nicotine on the movements of the intestine, and in 1878 was appointed extraordinary professor in experimental pathology. He was the author of numerous publications, but his chief work was "The Physiology and Pathology of the Circulation" (1892), which he dedicated to his former teacher, the celebrated physio-

logist Karl Ludwig. Basch is best known for his invention of a sphygmomanometer, by which he inaugurated the clinical measurement of the blood pressure. He also did valuable work on pulmonary œdema, cardiac dyspnœa and the innervation of the uterus. His death took place on April 25, 1905.

Local Government in Roman Britain

A DOCUMENT of importance in its bearing on the organization of local government in Roman Britain has been brought to light in the course of the fifth season's excavation on the site of the Roman town of Brough, which has just closed. The investigation of this site, which is situated on the north bank of the Humber, commanding the crossing of the river by the Lincoln-York road, is being carried out by the Brough Excavation Committee under the direction of Mr. Philip Corder and the Rev. T. Romans. The present season's work has been directed to laying bare one of the four towers of rectangular form, twenty-five feet wide by ten feet deep, which were added to the front wall of fortification, possibly early in the fourth century. The most important find of the season was an inscribed slab, 2 ft. 3 in. high by, originally, about four feet long (*The Times*, August 27). Mr. Eric Birley reports on the inscription that it commemorates the provision of a stage at his own expense by Marcus Ulpius Ianuarius, *Ædile* of the village of Petuaria, in honour of the Imperial family of Antoninus Pius (A.D. 138–161) and of the spirits of the deified emperors. This inscription confirms the name Petuaria, and is one of the few known instances of the epigraphic confirmation of Romano-British names.

FURTHER, and more important, the inscription affords evidence of a step in the development of the unit of local governments in Britain from the tribal area, here that of the Parisii, to the self-governing canton with its seat of government at the old tribal capital, or a newly erected town. Although such tribal cantons were known from inscriptions at Caerwent and Wroxeter, this is the first mention of a tribal magistrate in Britain. Furthermore, being denominated as the *Ædile* not of the tribal area, as in the previously known inscriptions, but of Petuaria itself, this indicates, in the interpretation of Mr. Birley, a further stage of development in which the central town with its college of four regular magistrates, two *duovirs* and two *Ædiles*, was gaining in importance at the expense of the tribal organization. This inscription is also the first epigraphic evidence of the practice in Britain of a magistrate conferring benefactions in return for the honour of election to office.

Arctic Weather Reports

ONLY forty-one years have passed since Nansen made his perilous and unsuccessful attempt to drift with the arctic ice from northern Siberia across the North Pole to the neighbourhood of Greenland, yet since July at least one London morning newspaper has been publishing daily a weather report from the region of the North Pole along with similar reports from New York and various Continental capitals. Such observations are not at present of great importance to weather forecasters, because the normal travel of weather systems generally tends to be circumpolar, and, moreover, the gap between the Pole and other arctic weather stations—even Spitsbergen—is a very wide one, so wide that it is impracticable to complete a system of isobars to cover the polar regions. But as a landmark in the gradual spreading of a network of observing stations over the whole world, this event is important. Owing to the drift of the ice, a permanent station at the North Pole is impracticable, but the Russian station from which the published observations have been received has apparently not drifted very far from the Pole yet. Its co-ordinates at the end of August were about lat. 87° N., long. 2° E. The reports include an observation of the direction of the wind, and owing to the fact that these are not made exactly at the Pole, the direction can be given in the ordinary manner. At the Pole itself, of course, all winds are from the south, and direction would presumably have to be given in terms of longitude instead of being referred to the points of the compass.

Problems of Conquering Everest

THE problem of reaching the summit of Mount Everest is discussed in a paper in the *Himalayan Journal*, 9, and takes the form of a memorandum prepared by the Eastern Section of the Himalayan Club, with some comments on the conclusions by Mr. E. Shipton. Two main suggestions are made in the light of past experience. The first is that expeditions have been foredoomed to failure because they have attempted to climb the north ridge too quickly. It is contended that men who have stood the strain of reaching the North Col cannot hope to do the remaining 6,300 feet in three days. The writers quote much evidence in favour of their statement, but Mr. Shipton is equally sure that above 23,000 feet a man deteriorates in muscle and energy quickly, and therefore delay at and above that height must be avoided. The second suggestion is that instead of trying in May and June when the effort is a race with the approaching monsoon, it would be better to make the attempt after the monsoon, in October or even in April. Days in October are certainly shorter than in May, but wind velocities so far as is known are slightly lower. Mr. Shipton admits that post-monsoon conditions should be studied, but prefers the pre-monsoon season. Major K. Mason points out that one obvious drawback to October is that it is a month of increasing wind, while May is a month of west winds decreasing owing to advancing monsoon currents.

The British Grid System

IN a paper on the British Grid system by Johnstone Wright, the engineer of the Central Electricity Board, presented to the Engineering Institute of Canada, at Montreal in June last, an interesting account is given of the development of the Grid system in

(*Continued on p.* 419)

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The History of Evolutionary Thought

as Recorded in Meetings of the British Association*

By Sir Edward B. Poulton, F.R.S.

President of the British Association

SIR WILLIAM THOMSON, in his address at Edinburgh in 1871, said that "the real origin of the British Association" was given in the words of a letter written by David Brewster to John Phillips on February 23, 1831, a few months before the first meeting: "The principal object of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress". That the time was fully ripe for the birth of the Association is made very clear by the words written by John Keble to a friend, referring to the D.C.L. degrees conferred, at the Oxford meeting in 1832, on David Brewster, Robert Brown, John Dalton and Michael Faraday: "The Oxford Doctors have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did"—an opinion on which Lord Salisbury commented at the Oxford meeting in 1894: "It is amusing at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit". It is not only amusing but also pathetic that such words should have been used by a revered member of a University which had done splendid service for science, as has been so well shown in Dr. R. T. Gunther's volumes[1].

Faced by the serious duty of preparing this address, I felt that the best hope of interesting you would be to choose a subject which has received special attention at our meetings. I have selected the progress of thought on organic evolution as it may be followed in addresses, papers, and discussions, mainly restricting myself to the series of meetings which began with the jubilee at York in 1881, the first of many that I have had the pleasure of attending.

The British Association provides a very favourable field for the discussion of many-sided subjects such as evolution—subjects which attract members from very different, as well as from closely related, sections. Hence a wide range of varied experience is open to one who can look back over more than half a century; and I do not propose to exclude some of the humorous sayings and incidents which, from time to time, have enlivened our meetings and contributed to their success. Some of them certainly deserve to be rescued from oblivion, although to perform this pious duty I must risk the enmity of the Goddess of Folly, who as Erasmus tells us, proclaimed: "I hate a man who remembers what he hears".

The fiftieth anniversary at York was a memorable meeting, with Sir John Lubbock (Lord

* PRESIDENTIAL ADDRESS DELIVERED AT NOTTINGHAM ON SEPTEMBER 1.

Avebury) as president, and the chair of every section except economics, under Grant Duff, taken by a past-president of the Association.

I then enjoyed to the full one of the chief benefits conferred by our Association upon its younger members—the opportunity of meeting older men, up to that time only known to them by the fame of their discoveries. Prof. O. C. Marsh had come over from Yale, his main object being to buy for his University Museum the second and more perfect fossil of the wonderful ancestral bird *Archæopteryx*, with teeth and a long, lizard-like tail—clear evidence of reptilian origin. The earlier example had been bought for the British Museum at a price which was said to have provided the dowry for a professor's daughter, and Marsh soon realized, as he told me, that the second was not for sale on any terms. "We let the other go and I believe they would kill me if this were sold" was the reply given to him by the authority in Munich. He was, however, able to study the fossil, and his description and drawings of the teeth, in the Geological Section, followed the only attack on evolution itself, as distinct from its causes, which I have ever witnessed at any of our meetings. It was the exhibition by H. G. Seeley of his reconstruction of *Archæopteryx* from this fossil, which aroused the fury of the palæontologist, old Dr. Thomas Wright of Cheltenham: "Archæopteryx hasn't got a head, how can it possibly have teeth?" he growled, knowing nothing of the latest find or of the fact that a detached head and scattered teeth had been detected on the slab in which the older specimen was embedded. In spite of Prof. Newton's positive statement and the form of the teeth, drawn by Prof. Marsh at the request of the chairman, Dr. Wright, quite unconvinced, continued muttering "Archæopteryx is a very good bird", its virtue in his opinion entirely uncontaminated by any taint of reptilian affinity.

Prof. Marsh also read a paper in the Zoological Section on his own wonderful discoveries of toothed birds from the rocks of the western United States. Richard Owen, president of the Section, was in the chair and, with the memory of old and embittered controversies in his mind, the author told me that he had felt rather anxious in bringing this communication forward. But in that friendly atmosphere there was no reason for alarm. Owen welcomed the paper warmly and in confirmation told us, in the most charming manner, of the traces of teeth found in an embryo parrot.

Fossils as Evidence of Evolution

The event which stands out most clearly in m memories of the jubilee meeting is Huxley evening lecture on "The Rise and Progress Palæontology"—the science which provides a essential part of the foundation on which ge graphical, geological and biological evolutiona history has been built. The insuperable difficult felt by the older naturalists was to believe that th land had been for the most part deposited und the sea, and to account for the presence of fossil or as they were called, 'formed stones'. The tru solution, Huxley explained, was found and pu lished in 1669 by Nicholas Steno, a Danish pr fessor of anatomy at Florence, who careful studied certain fossils, known as 'glossopetra which abounded in the Tuscan rocks and we believed to be fossil fig-leaves. Steno, who w not satisfied with this interpretation, dissected shark's head and showed that the 'glossopetra exactly corresponded in every particular with th teeth—"that in fact they were shark's teeth The emphasis with which Huxley made this stat ment comes back to me after the lapse of near sixty years. From this, Steno was led to conclud that they were the teeth of shark-like fish living in the Tuscan Sea and later embedde with other remains, in the strata which had the accumulated.

I have not noticed the fanciful suggestion "fossil fig-leaves" in any published version account of Huxley's lecture that I have see but he certainly told us of it and it is an interes ing example of the attempts made by the naturalis of the day to explain the fossils embedded in roc then believed to be of terrestrial origin. I cann resist the temptation of quoting Plot's[2] mo ingenious and amusing effort to account for th well-known layer of oyster-shells (*Ostrea bellovacin* found ". . . at some places here in *Englan* particularly at *Cats-grove* [now Katesgrove] ne Reading . . .; which how they should come he without a *Deluge*, seems a difficulty to most m not easily avoided".

Plot was, however, helped "to a *salvo*" for h own objection by remembering that Reading w "a *Town* of very great *action* during the *Invasio* of the *Danes*, who cutting a deep trench cro between the *Kennet* and *Thames*, and inclosi themselves as it were in an *Island*, held it again King *Ethelred*, and *Alfred* his Brother a conside able time; from whence in all probability, th

Saxons having removed their *Cattle* and other provisions before the *Danes* arrival, 'tis likely that they might be supplyed from their *Navy* with *Oysters*, which during the time of the aboad of the *Army* on Land, might be a very suitable employment for it: Which conjecture, if allowed, there is nothing more required to make out the possibility of the bed of *Oysters* coming thither without a *Deluge*, but that *Cats-grove* was the place appointed for the *Armies* repast".

The probability of this suggestion may be inferred from the age of the 'Woolwich and Reading' beds in which the oysters are found—estimated by Prof. W. W. Watts and Prof. H. L. Hawkins at about 50–60 million years.

Dr. Plot's explanation of fossils in general, as well as of flowers, was of a very different kind. To account for their existence he appealed to "the wisdom and goodness of the *Supreme Nature*, by the *School-men* called *Naturans*, that governs and directs the *Natura naturata* here below, to beautifie the World with these varieties; which I take to be the end of such productions as well as of most *Flowers*, such as *Tulips*, *Anemones*, &c. of which we know as little use as of formed stones".

The modest and withal amusing paragraph which follows I venture to quote in full as an example to be followed in scientific controversy:

"And thus I have given the grounds of my present *opinion*, which has not been taken up out of *humor* or *contradiction*, with intent only to affront other worthy Authors modest conjectures, but rather friendly to *excite them*, or any *others*, to endeavor collections of *shell-fish*, and parts of other *Animals*, that may answer such *formed stones* as are here already, or may hereafter be produced: Which when ever I find done, and the reasons alleged *solidly* answered, I shall be ready with acknowledgment to retract my *opinion*, which I am not so in love with, but for the sake of *Truth* I can chearfully cast off without the least reluctancy".

One chief object which, as I believe, Huxley had before him was to bring forward a calm, clear statement of the evidence on which alone it was possible to achieve that "reconstruction of an extinct animal from a tooth or bone", which had made so deep an impression on the imagination. The reconstruction was in fact a simple inference based on anatomical experience such as that gained by Steno when he dissected the shark and concluded that the 'glossopetræ' were the teeth of shark-like fishes. But this reasoning—that a fossil tooth or bone on the surface of a rock, cannot by itself enable the geologist to predict that a skeleton of a certain type lies hidden beneath—seeming to diminish the glory of Cuvier's splendid work, was resented by Owen, who had replied with the bitter taunt that a tooth can tell us a great deal—a donkey can kick his master but he cannot eat him. This may have been the encounter referred to by Huxley when he wrote of a friendly meeting with Owen at the Zoological Section of the Association in Leeds (1858): "so that the people who had come in hopes of a row were (as I intended they should be) disappointed"[3]. In the same spirit, I think, Huxley was glad to speak of the 'glossopetræ' at the jubilee meeting, where Owen was president of a section, and calmly and simply, to reaffirm conclusions which are unassailable.

Huxley then passed on to Steno's further study of fossils and his proof of their relationship to terrestrial freshwater and marine organisms, and to his application of this evidence to the past condition of Tuscany—all discussed "in a manner worthy of a modern geologist" and later extended by Buffon to all parts of the world then known to be fossiliferous. These conclusions, "which almost constitute the framework of palæontology", only required one addition, made towards the end of the eighteenth century by William Smith, who showed that geological strata contained characteristic fossils so that rocks of the same age could be identified in all parts of the world, while the biologist could follow the changes in the living population of the globe—a record of constant extinction and continual generation of new species. We were then led to three general conclusions: (1) the vast length of time during which life has existed on the earth—"certainly for millions of years"; (2) the continual changes which living forms have undergone during this period; (3) the successive changes in the best-known fossil groups are such as we should expect if each series "had been produced by the gradual modification of the earliest form. . . ." This last conclusion meant evolution which so completely accorded with recent discoveries that "if it had not existed, the palæontologist would have had to invent it".

I can never forget the words spoken to me after the lecture by a dear friend of my youth, the late Viriamu Jones, Principal of University College, Cardiff: "At every sentence I felt myself bowing to Huxley and saying 'you are the greatest man here; no one else could have said that as you have said it' ".

Age of the Earth

As Huxley's lecture continued in a calm spirit an embittered controversy, so his thoughts on the immensity of past geological and biological time lead naturally to another controversy on the age of the earth conducted intermittently at our meetings between 1892 and 1921. It is, I think, a good example of the invaluable help which the British Association brings to discussion when there appears to be a difficulty in reconciling the conclusions reached by the followers of different sciences. Lord Kelvin's estimate of a hundred million years as the period during which the earth had been cool enough to permit the existence of life upon its surface—a period reduced by Prof. Tait to ten million—was a great difficulty to geologists and biologists, who believed that an immensely longer time was required for the history of the fossiliferous rocks and the evolution of animals and plants. Thus, to quote only one instance, Darwin writing to Wallace in 1871 and referring to 'missing links', said, "I should rely much on pre-Silurian time; but then comes Sir William Thomson, like an odious spectre". The geologists resisted more firmly. Thus Sir Archibald Geikie, in his presidential address at Edinburgh in 1892, concluded his discussion of the subject with these words: "The geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede".

At the Leeds meeting in 1890 I had many opportunities of meeting Prof. John Perry, and when we were walking together on the Sunday afternoon, I asked him to tell me something of the Kelvin-Tait conclusions and how far they must be accepted. He had been a demonstrator under Kelvin and spoke of the intense interest with which he had followed his lectures at Glasgow, and he gave me no hope of escape. His change of opinion, throwing a most interesting light upon the influence of the British Association, was the result of the presidential address at Oxford in 1894, when Lord Salisbury chaffed the believers in natural selection, telling them that he did not wonder that they required many hundred million years for so slow a process, but that "if the mathematicians are right, the biologists cannot have what they demand. . . . The jelly-fish would have been dissipated in steam long before he had a chance of displaying the advantageous varia which was to make him the ancestor of the hu race".

When Perry read this pronouncement, swee aside the firm convictions of biologists and logists, he was led to re-examine the evidence soon found a flaw. The heat of the earth had calculated on the assumption of a conducti uniform through the whole mass, but P showed that, with a conductivity becor higher with increasing depth, the Kelvin- estimate of the time required for cooling to existing temperature—on which the age of habitable earth had been based—must be mensely lengthened. Perry told me of destructive criticism and very kindly helped to make use of it in the address to Section I Liverpool in which I replied to Lord Salisbu amusing attack on the evolutionists.

Lord Lister was our president at Liverpoo 1896, and I cannot resist the temptation to dig for a moment and recall the address in which of the greatest benefactors of mankind told with the utmost simplicity and modesty, the s of his life's work and the success which, in s of all opposition, had been achieved. To hear was an enduring inspiration.

The year 1896 was also the jubilee of I Kelvin's wonderful half-century of achieven in research and teaching, and I could not feeling some regret that any criticism of his v should appear at this particular time. But in kindly spirit of our Association such doubts quite unnecessary. I well remember how he c one day to our sectional committee-room to b me some volumes of his works, and how, as I h recorded before, in the following year as we travelling across Canada after the Toronto mee and the chance of collecting insects for a minutes at each station could not be resisted, I Kelvin said to his wife, "My dear, I think we n forgive Poulton for thinking that the earth i very old when he works so hard in one day ou all the endless millions of years in which believes!"[4]

The one line of evidence which left some anx in 1896 was suggested by Helmholtz, who allo the sun only eighteen million years to have l giving out radiant heat at the present rat period Lord Kelvin was willing to extend to million—and this estimated maximum was accepted by Sir George Darwin, who, in

address[6] at Cape Town in 1905, spoke of the new evidence obtained by M. and Mme. Curie in their proof that radium gives out heat, and quoting in confirmation the work of R. J. Strutt, W. E. Wilson and G. H. Darwin, finally concluded that "the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure unknown". The light thrown by radium upon the Helmholtz estimate was also referred to in the presidential address of Ray Lankester at York in 1906, of J. J. Thomson, quoting the work of Strutt, Joly and Rutherford, at Winnipeg in 1909, and became a predominant subject in the joint discussion on the age of the earth, between Sections A, C, D and K, at Edinburgh in 1921[6]. Lord Rayleigh, in opening this discussion, concluded "that radioactive methods of estimation indicate a moderate multiple of 1,000 million years as the possible and probable duration of the earth's crust as suitable for the habitation of living beings. . . ."

Geologists and biologists do not profess to know the age of the earth as the abode of life, but they are sure that, in the words used by Sir William Turner at Bradford in 1900, its birth "must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval".

Organic Evolution

I fear that too much of our time has been occupied by the attempt to show that the field is clear for the discussion of organic evolution, but until this could be done any such discussion appeared to be wellnigh useless.

It is, I think, a mistake to emphasize too strongly the very natural shock received by many who read the "Origin" or heard of its teaching for the first time and without any preparation; and I believe an even greater mistake to criticize the clergy for the time that elapsed before their acceptance of the new teaching. I shall never forget the reception of Aubrey Moore's paper, "Recent Advances in Natural Science in their Relation to the Christian Faith", by the Church Congress at Reading in 1883[7]. No speaker could have carried his audience with him more thoroughly: there was not a single protest or indication of dissent—nothing but enthusiastic applause. The Bishop of Oxford, Dr. Mackarness, was in the chair when the paper received this unanimous welcome—only twenty-three years after the Oxford meeting at which another Bishop of Oxford put his rude and foolish question to Huxley. It is pleasant to know that their celebrated encounter left no bitterness, for Huxley wrote in 1891 to Francis Darwin—"In justice to the Bishop, I am bound to say that he bore no malice, but was always courtesy itself when we occasionally met in after years".

I remember as a youth receiving a gentle parental warning against committing myself too entirely to a belief in evolution—a very different experience from that of our president at Hull in 1922, Sir Charles Sherrington, who in 1873 was persuaded by his mother to take the "Origin" with him on his summer holiday, with the inspiring words—"It sets the door of the Universe ajar!"

I have already recalled Dr. Wright's indignation at York in 1881 as my only experience of opposition to a belief in organic evolution at any of our meetings, and the published proceedings confirm this impression of unanimity. Thus, R. H. Traquair, addressing the biologists at Bradford in 1900, said, "I hardly think that we should now find a single scientific worker who continues to hold on to the old special creation idea"; and Lord Salisbury at Oxford in 1894, referring to Darwin, said, "He has, as a matter of fact, disposed of the doctrine of the immutability of species. It has been mainly associated in recent days with the honoured name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world". The mention of this great American naturalist recalls Tyndall's fine address at Belfast in 1874 and his memories of Agassiz's words, "I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible".

Huxley, who had seconded the vote of thanks to Lord Salisbury, wrote to Hooker a few days later: "It was very queer to sit there and hear the doctrines you and I were damned for advocating thirty-four years ago at Oxford, enunciated as matters of course—disputed by no reasonable man!—in the Sheldonian Theatre by the Chancellor. . . ."[8]

A letter written two days earlier to Boyd Dawkins records Huxley's opinion of another part of the address. "Lord Salisbury gave himself away wonderfully, but he was so good about Darwin himself that I shut my eyes to all the nonsense he talked about Natural Selection"[9].

Motive Causes of Organic Evolution

Leaving now the subject of organic evolution itself, as generally accepted, I wish to speak on the difficult question of its motive causes which for many years have formed the subject of addresses, discussions and papers at our meetings. The great division into two opposed theories of causation became clear in 1887, when Weismann attended the meeting at Manchester, and a discussion on "The Hereditary Transmission of Acquired Characters" was held in Section D. From that time, evolutionists attending our meetings have been either 'Lamarckians', following Erasmus Darwin, Lamarck, Buffon and Herbert Spencer, or 'Darwinians' who followed Darwin and Wallace. Darwin himself, however, included the Lamarckian conception of 'use-inheritance' as a motive cause, although believing it to be far less important than natural selection. The term 'Neo-Darwinian' has therefore been applied to those who, accepting Weismann's teaching, reject 'use-inheritance' altogether.

It must always be remembered that, apart from any theory of causes, the world owes its belief in organic evolution to all the great men whose researches and teaching have founded the two schools, and perhaps chiefly, at any rate among the English-speaking nations, to Herbert Spencer. I was first led to realize the extent of his trans-Atlantic popularity when I learned from an American story greatly enjoyed in those far-off undergraduate days, that his books were keenly appreciated by a bashful hero, who was so far from sharing the sublime confidence of their author, that he was only led to perform the most fateful action in life by the pressing advice of a very young nephew who assured him, in the presence of the lady, that if he was fond of her, the proper thing to do was to kiss her. Herbert Spencer's infallibility certainly lent itself to such stories as that of his supposed reply to an argument—"That can't be true, for otherwise 'First Principles' would have to be re-written—and the edition is stereotyped"; or how Darwin said that to read Spencer always made him feel like a worm, but that he retained the worm's privilege of wriggling, and at another time "wonderfully clever, and I dare say mostly true". But, allowing for a style which provoked these and other amusing comments, we must never forget that believers in the doctrine of organic evolution owe an immeasurable debt to Herbert Spencer.

James Russell Lowell's amusing lines in "Biglow Papers"[10] appear to prove that marckism was prevalent in America many ye before the "Origin":

"Some flossifers think thet a fakkilty's granted
The minnit its proved to be thoroughly want

. . . . .

Ez, fer instance, thet rubber-trees fust beg
bearin'
Wen p'litikkle conshunces come into wearin',—
Thet the fears of a monkey, whose holt chan
to fail,
Drawed the vertibry out to a prehensile tail'

The year of the Manchester meeting, 1887, the fiftieth anniversary, and we are now c brating the centenary, of the entry in Darw pocket-book:

"In July opened first note-book on Transmu tion of Species. Had been greatly struck from ab the month of previous March on character of So American fossils, and species on Galapagos Ar pelago. These facts (especially latter), origin all my views".

It is especially interesting to recall that th views, as Prof. Newton told us in his address Section D, the biological section, did not incl natural selection, which only came into Darw mind when he read Malthus, "On Population" October 1838. Newton, who had read the pr sheets of the great "Life of Darwin", publis later in 1887, then spoke of Wallace's indepen discovery, made twenty years after Darwin' discovery suggested to him also by reflecting Malthus, and of the friendship between the great men to whom this fruitful conception come, referring the cynic who would "point finger of scorn at the petty quarrels in wh naturalists unfortunately at times engage" to "greatest of all cases, where scientific rivalry only did not interfere with, but even strengthe the good-feeling which existed between two of most original investigators". Here I cannot r the desire to quote a part of the speech made Wallace at the most thrilling scientific gathe I have ever attended—the fiftieth anniversar the Darwin-Wallace essay read before the Linn Society on July 1, 1858, only twelve days a the arrival of Wallace's letter and manuscript f the Moluccas. Wallace then said, on July 1, 1

"The idea came to me, as it had come to Dar in a sudden flash of insight: it was thought in a few hours . . . and sent off to Darwin

within one week. *I* was then (as often since) the 'young man in a hurry' : *he*, the painstaking and patient student, seeking ever the full demonstration of the truth that he had discovered, rather than to achieve immediate personal fame. . . . If the persuasion of his friends had prevailed with him, and he had published his theory, after ten years'—fifteen years'—or even eighteen years' elaboration of it—*I* should have had no part in it whatever, and *he* would have been at once recognized, and should be ever recognized, as the sole and undisputed discoverer and patient investigator of the great law of 'Natural Selection', in all its far-reaching consequences"[11].

Amusing evidence of the difficulty with which this "great law" was understood is afforded by a verse written by Lord Neaves and dated May 1861 :

"A deer with a neck that was longer by half
Than the rest of its family's (try not to laugh),
By stretching and stretching, became a Giraffe,
Which nobody can deny"[12].

Yet Wallace, referring to Lamarck's hypothesis and "that now advanced", had written in his section of the joint essay :

"Neither did the giraffe acquire its long neck by desiring to reach the foliage of the more lofty shrubs, and constantly stretching its neck for the purpose, but because any varieties which occurred among its antitypes with a longer neck than usual *at once secured a fresh range of pasture over the same ground as their shorter-necked companions, and on the first scarcity of food were thereby enabled to outlive them*".

There were fortunately others who did not launch such ill-aimed criticism. Thus Prof. Newton, reminding the Section that the new teachings had been at once accepted by Canon Tristram[13] before the appearance of the "Origin of Species" (on November 24, 1859), expressed, with all the enthusiasm of one who was devoted to the same delightful branch of natural history, "the hope that the study of ornithology may be said to have been lifted above its fellows". It was indeed very fortunate that the Darwin-Wallace essay should have been read so soon after its appearance by a naturalist who looked on the species question as did Tristram—a great traveller and observer who studied indefatigably the birds he loved, as living creatures and in as many countries as he could visit.

At the last meeting of the British Association in Nottingham (1893) Canon Tristram was president of Section D and, in his address, gave an account of the observations referred to by Newton at Manchester. The historic interest of this early acceptance of natural selection is such that I have prepared a brief abstract of his chief conclusions :

During a visit of many months to the Algerian Sahara in 1857–58, he "noticed the remarkable variations in different groups, according to elevation from the sea, and the difference of soil and vegetation". On his return he read the Darwin-Wallace essay and wrote, "It is hardly possible, I should think, to illustrate this theory better than by the larks and chats of North Africa". He then explained how the colours arose by selective destruction of birds which harmonized less well than others with the surface of the desert ; and similarly with other larks having "differences, not only of colour, but of structure", chiefly "marked in the form of the bill". He took as examples a very long-billed lark (*Galerita arenicola*), resorting exclusively to the deep, loose, sandy tracts, and a very short-billed allied species (*G. isabellina*), haunting the hard and rocky districts. He then pointed out that there is individual variation in the bills of larks and that the shorter-billed birds would be at a disadvantage in obtaining food from sandy areas but at an advantage among the rocks where strength is required. He concluded, "Here are only two causes enumerated which might serve to create, as it were, a new species from an old one. Yet they are perfectly natural causes, and such as I think must have occurred, and are possibly occurring still. We know so very little of the causes which, in the majority of cases, make species rare or common that there may be hundreds of others at work, some even more powerful than these, which go to perpetuate and eliminate certain forms 'according to natural means of selection' ".

The temptation to record an amusing incident which happened at one of the meetings of Section D at Manchester cannot be resisted. Work was proceeding smoothly under the genial guidance of Prof. Newton when, suddenly, Dr. Samuel Haughton of Dublin entered and from the back of the room announced in arresting tones that he had an important communication to make about the animals preserved from the Flood. He believed that Mrs. Noah strongly objected to her husband's intention to take the elephants on board, fearing that their weight would cause a dangerous displacement of the Ark's metacentre.

How this domestic difference was composed we had no opportunity of learning, for as the chairman, whose expression combined sympathetic amusement with mild deprecation, was rising and about to protest, Dr. Haughton, anticipating the result, had already turned towards the door, telling us over his shoulder that he was on his way to make a fuller communication on the subject to the Anthropological Section.

Acquired Characters

After this brief description of an event, which I hope you will agree ought not to be forgotten, we must return to organic evolution and to one of the most important subjects debated at any time before a meeting of the British Association—the question, "Are Acquired Characters Hereditary ?" —brought before the world by Prof. August Weismann, who was present at Manchester and spoke in the discussion (unfortunately not reported), introduced by Ray Lankester, in which Dr. Hubrecht, Patrick Geddes, Marcus Hartog and I took part. Weismann's conclusion that "acquired characters" are not inherited was held by Prof. E. S. Goodrich, in his address to Section D at Edinburgh in 1921, to be "the most important contribution to the science of evolution since the publication of Darwin's 'Origin of Species' ", an opinion with which the great majority of biologists will agree, although the terms employed for the two classes, the inherited and the non-inherited, together with the ideas underlying them, were shown by Adam Sedgwick, at Dover in 1899, Archdall Reid, and others, as well as by Goodrich himself, to be incorrect. Nevertheless it will probably be impossible to abandon the word 'acquired', employed by Erasmus Darwin (1794), Lamarck (1809), and Prichard (1813) as well as by later authorities. Whenever environmental conditions are followed by characteristic changes, absent when these conditions are absent ; or when such changes follow the use or disuse of the parts of an organism, or the education it has received, then we have before us the 'acquired' characters maintained by Weismann to be incapable of hereditary transmission. This vital conclusion, accepted, as I believe it is, by nearly all biologists, is not appreciated as it ought to be by the general public. A brief statement of a single piece of evidence may convince some who are doubtful about a conclusion with which human life is very deeply concerned.

My old friend the late A. A. Macdonell, pro of Sanskrit at Oxford, spoke two langu English and German, as they are spoken by n Englishmen and Germans. I asked him wh he thought it was possible for any mature p to learn a foreign language so perfectly th would be mistaken for a native. He replied he was sure it could not be done, and tha own ability to speak the two languages as h had been only made possible because as a child he had been continually taken back and forwards between the two countries. Ye human being transported as a baby from his country to another and brought up there a the natives will learn to speak as they speak the past generations, however many, during his ancestors spoke the language of his birth will count for nothing, will not retard his acqui of another tongue or modify it in any way.

An interesting and amusing example is pro by the futile striving of an Englishman to pron the Welsh double-l, generally attempted b substitution of 'th'. Even the advice given Welsh clergyman to the English bishop o diocese is unlikely to bring success : "You put the tip of your Right Reverend tongue ag the roof of your Right Reverend mouth, and like a goose".

The result of education as an 'acquired' cha in the Weismannian sense is of such s importance that I think it is well to quot conclusions stated by Ray Lankester in his ad to the seventy-fifth meeting of the Associati York. He then maintained that the "pow building up appropriate cerebral mechanis response to individual experience, or what be called 'educability', is the quality which acterises the larger cerebrum and is that has led to its selection, survival and further inc in volume . . . 'Educability' can be transmi it is a congenital character. But the *resu* education can *not* be transmitted. In each ge tion they have to be acquired afresh. . . . O other hand, the nerve-mechanisms of instinc transmitted, and owe their inferiority as com with the results of education to the very fact they are *not* acquired by the individual in rel to his particular needs, but have arisen by sele of congenital variation in a long series of prec generations"[14].

Lankester was led by these conclusion reject altogether the theory of G. H. Lewe Romanes, and others, "that instincts are d

lapsed intelligence", a theory also disproved by Lloyd Morgan's observations on young birds described by him at the Ipswich meeting in 1895[15]. Another very important subject brought forward by Lankester was the evidence, originally published by him in 1894[16], that Lamarck's first and second laws of heredity "are contradictory the one of the other, and therefore may be dismissed". His statement may be briefly summarized as follows :

The first law assumes that in spite of thousands of generations during which a normal environment has "moulded the individuals of a given species of organism, and determined as each individual developed and grew 'responsive' quantities in its parts (characters) ; yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions . . . and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual . . . shows *new* responsive quantities in those parts of its structure concerned, new or acquired characters".

"So far, so good. What Lamarck next asks us to accept, as his 'second law', seems not only to lack the support of experimental proof, but to be inconsistent with what had just preceded it. The new character which is *ex hypothesi*, as was the old character . . . which it has replaced—a response to environment . . . is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared . . . to be capable of transmission by generation ; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it".

The effect of Lamarck's laws on the hereditary transmission of acquired characters would be this : "a past of indefinite duration is powerless to control the present, while the brief history of the present can readily control the future".

After hearing a very condensed statement of conclusions so essentially bound up with the progress of organic evolution, I feel sure that you will wish to be reminded of Prof. Ewing's words which followed the address at York :

"Now is the winter of our discontent made glorious summer by this Ray of Lankester".

Returning to the unreported discussion on the inheritance of acquired characters at Manchester, I venture to bring forward certain observations opposed to a belief in Lamarckian evolution by means of inherited experience—observations which I then described and have not known to be answered. In the relationship between enemy and prey there is very commonly no opportunity for the latter to learn by experience. The wonderfully elaborate adaptations by which sedentary insects are hidden from enemies have been evolved, not by experience of enemies but by avoidance of enemies. In these examples—and they are numberless—we are driven to accept Weismann's conclusion and with him to invoke "the all-sufficiency of Natural Selection".

When one of the twig-like caterpillars, of which there are so many in Great Britain, is detected by an insectivorous bird, it can do nothing and is devoured at once. Its one defence is the astonishingly perfect resemblance to a twig of the bush or tree on which it lives. It is firmly fixed and its weight also supported by an almost invisible thread so that it cannot escape as many caterpillars do by dropping to the ground and sheltering in the grass or among dead leaves. Its one chance of survival is to gain so perfect a disguise that it will not be seen, and to gain this end the adaptive devices are most elaborate and wonderful : its twig-like shape and colours, with the power of gradually adjusting these so as to resemble the bark of the bush or tree on which the parent moth laid the egg from which it came, even the power to reproduce exactly the appearance of lichen, the rigid stick-like attitude maintained during the hours of daylight. Finally there is the evidence, recently obtained by Robert Carrick[17], that the disguise *does* protect ; for examples of one of these caterpillars, resting on a branch of its food-plant fixed over a wren's nest containing young, were unnoticed by the parent bird which used the same branch as a convenient perch ; yet seen and at once taken when placed on a white surface below.

One of the best examples of a prophetic instinct is to be found in the larva of an African Tabanid fly (*T. biguttatus*). This maggot lives and feeds in soft mud which, during the dry season when the chrysalis stage has been reached, will be traversed in all directions by wide and deep cracks in which insectivorous animals can search for prey. But the maggot, while the mud is still soft, prepares

for this danger. By tunnelling spirally up and down it makes a line of weakness which will cause a pillar to separate from the mass when the mud hardens and contracts. It then tunnels into the still soft pillar and becomes a chrysalis in the centre of its deeper end. However wide the cracks which appear in the mud, the maggot has arranged beforehand that they will not invade its cylinder. Dr. W. A. Lamborn, who made this most interesting discovery, observed that the summits of the pillars, forming circular disks of about the size of a penny, scattered here and there over the surface, were never thus traversed, but that an empty shell was protruding from the centre of each when the fly had emerged[18]. My friend the late Prof. J. M. Baldwin, the distinguished American psychologist, well remembered at many of our meetings, wrote when he heard of this discovery: "it seems *complete*—one of those rare cases of a single experience being sufficient to establish both a fact and a reason for the fact! It is beautiful".

I would ask any believer in Lamarckian evolution, or in Hering's and Samuel Butler's theory of unconscious memory residing in the germ-cells, how it would be possible to explain these prophetic instincts, adapted not to meet but to avoid future experience, except by the operation of natural selection.

The appeal to orthogenesis, or internal developmental force, as the motive cause of evolutionary progress, has often been made—generally by palæontologists rather than by the observers of living forms. Any such belief in the potency of an internal tendency is, I think, open to the criticism made by Thiselton Dyer in his address to Section D at Bath in 1888: "This appears to me much as if we explained the movement of a train from London to Bath by attributing to it a tendency to locomotion. Mr. Darwin lifted the whole matter out of the field of mere transcendental speculation by the theory of natural selection, a perfectly intelligible mechanism by which the result might be brought about. Science will always prefer a material *modus operandi* to anything so vague as the action of a tendency".

Mendelism

It is not necessary for me to speak on the rediscovery of Mendel's great work and all that it has meant to our biological sections in the early decades of the present century. The recent developments, following the work of Haldane, R. A. Fisher and others, and the vitally important relationship between Mendelism and natu selection were brought before us last year Julian Huxley's illuminating address to Section The older belief that only large variations, mutations as they then began to be called, w subject to Mendelian inheritance, and that sn variations were not inherited at all, disappea when further researches proved that extrem minute differences were "heritable in the nor manner"[19], and, with this, the foundation Darwinian evolution became immensely streng ened. It is also right to remember that Bates the leader of Mendelian research in Great Brit always believed in natural selection, regardin indeed as self-evident and not very interest Also that Ray Lankester, as long ago as his 1 address at York, maintained that however Mendelism was advanced, it "would not be s versive of Mr. Darwin's generalisations, probably tend to the more ready application them to the explanation of many difficult ca of the structure and distribution of organisms'

The relationship between the germinal foun tion of Mendelian and Weismannian hered was considered in a paper by L. Doncaster r before Section D at the South African meetin 1905. He then maintained that Weisma "hypothesis that the material bearer of heredit qualities is the chromatin of the nucleus" of germ-cells had been confirmed by recent work their maturation, which "has shown that t contain a mechanism which seems preci adapted to bring about that segregation of cha ters which forms the most fundamental part the Mendelian theory, and it seems hardly poss that the two things are unconnected". MacB also in his address to the same section at Newca in 1906, spoke of the "great epoch-making covery of experimental embryology, viz. existence of *specific organ-forming substances*'

These fundamental discoveries bring to min conversation with Weismann when he had b finally driven to frame and elaborate this hy thesis, and was so appalled by the number minuteness of the material bearers of heredit qualities contained in a single germ-cell that he told me, he could not believe that the physic and chemists were correct in their conclus about the size of the atom. He admitted t diverse lines of evidence led to the same res but even so, he believed the future would pr that physicists were mistaken and that the a was far smaller.

Natural Selection To-day

It is impossible to say more than a few words about the very interesting and important discussion on "The Present State of the Theory of Natural Selection" held at the Royal Society on May 14 last year. The subject was approached from many points of view by both zoologists and botanists, and their conclusions were very welcome to Darwinians who remembered the earlier opinions expressed when Mendel's great work was rediscovered. I think, however, that Prof. D. M. S. Watson, in the opening address, was inclined to underestimate the value of the existing evidence for a "selective death rate", although everyone will agree that "any new evidence . . . or indeed any suggestion of cases which might be capable of investigation", would be most desirable.

I may briefly mention a few experiments brought before Section D at the Bristol meeting in 1898, beginning with the work of Weldon and Thompson on the common shore crab, showing that the effect of china clay and other impurities in the sea at Plymouth was selective and promoted changes of shape which ensured that the water flowing over the respiratory surface was more efficiently filtered.

Then, on the subject of chance, the heroic help rendered by Mrs. Weldon, who four times recorded the result of 4,096 throws of dice, showing that the faces with more than three points were, on the average, uppermost slightly more often than was to be expected. It comes back to me very clearly because of the interesting explanation—that the points on dice are marked by little holes scooped out of the faces, and that points 6, 5, and 4, respectively opposite 1, 2, and 3 are somewhat lighter, more of the ivory having been removed; also because of Francis Galton's delight and his humorously expressed wonder whether the facts had been realized by those who had an interest other than scientific in the throwing of dice.

Experimental evidence was also submitted by Miss Cora B. Sanders (Mrs. C. B. S. Hodson) and myself, proving that when the rough, angular pupa of the small tortoiseshell butterfly "is suspended from a surface against which it stands out conspicuously, it is in far greater danger than when it is fixed to one upon which it is concealed".

To the observer of living creatures, however, the most convincing evidence is provided by animals themselves. When a wild bird is seen to capture some conspicuous butterfly or moth and then immediately to reject it, the association between inedibility and a warning colour is more convincingly suggested than when insects are offered to animals in confinement, although such experiments are of great value and often provide the only available evidence. There are, however, instances in which abundant data for statistical investigation are furnished by the wild animals themselves. Thus the long-eared bat has the convenient habit of eating moths—its regular food—while it hangs suspended from a surface to which it returns after each capture; and as the wings are rejected, these may be collected in large numbers, yielding valuable information on the significance of concealing and warning patterns.

In the attempt to determine the motive causes of organic evolution, the work of the naturalist, the student of living nature, is essential. His task is to do what Lyell did for geology by directing attention to the forces now in operation and seeking with their help to interpret the past, and in this work it is especially valuable to study adaptations which have been developed in recent times and can, in certain instances, be proved to undergo changes even now. Thus the interesting observations of H. Lyster Jameson showed that a pale local race of the common mouse had been formed, although incompletely, in 100–125 years, by the selective attacks of owls and hawks on sandhills near Dublin[20]. I therefore believe that the colours of animals provide one of the most fruitful fields in which to pursue these investigations, and I regret that this work has been recently attacked by an American zoologist who, referring to the recent revival of natural selection, continues—"if the doctrine can emerge minus its sexual selection, its warning colors, its mimicry and its signal colors, the reaction over the end of the century will have been a distinct advantage"[21]. It is of course impossible to discuss, on the present occasion, this confident attempt to depreciate the value of work associated with the names of Bates, Wallace, Trimen and Fritz Müller. I will only point out that their conclusions on warning colours and mimicry have been immensely strengthened and confirmed by the later observations of Guy Marshall, W. A. Lamborn, St. Aubyn Rogers, Hale Carpenter, V. G. L. van Someren and others in Africa; by the experiments conducted by some of these naturalists, and also by H. B. Cott and R. Carrick, and in the United States by Morton Jones.

It is interesting to remember that a paper by two American entomologists[22] was among the first to accept and support by fresh observations the conclusions brought forward by H. W. Bates in his great memoir on the mimetic butterflies of the Amazon valley[23], and that one of the authors treated the same subject more completely in a later paper[24] much appreciated by Darwin[25].

It is also important to remember that the above-mentioned conclusions have been reached by the study of marine animals no less than terrestrial, as was shown by Herdman in his address to Section D at Glasgow in 1901, and by his experiments communicated to the same section at Ipswich in 1895; also that Garstang, with his very long and intimate experience of marine life, adopts the same interpretation of colour and form with the associated attitudes and movements.

If time permitted it would be possible to speak of numerous papers on mimicry and the related subjects which have been brought before our meetings. It is impossible to attempt this now, but many will feel with me that the name of the late Dr. F. A. Dixey should not be forgotten—one who attended so regularly, so often read papers at our meetings, presided over Section D at Bournemouth in 1919, lectured at Leicester in 1907, always giving the results yielded by the study of his favourite insects, and their interpretation by the theory of natural selection; also one who delighted in the social gatherings of his Section.

Man and Animals

In my concluding remarks I am anxious to refer to a very interesting and encouraging subject—the feeling for animals and the care for their welfare to-day, as contrasted with the treatment they received a hundred years ago and even in the youth of many among us. Only last autumn, *The Times* of October 12 reported that 1,000 swallows had arrived at Venice "sent there by bird-lovers from Vienna and Munich in order to save them from the effects of the cold weather. Soon after their arrival they were set free and flew south along the Adriatic coast". A little earlier the writer of the amusing 'fourth leader' referred to a meeting of the Society for the Preservation of the Fauna of the Empire at which the care of the opossum was discussed, comparing this with the report of happenings a hundred years earlier when there was a "humorous debate" at the Zoological Society "about puffing cigar-smoke into the cages of the monkeys", to their evident dis comfort. The writer, yielding too far, we hope to the depression of the present day, concludes "The world, it may be, is 'man-sick' and yearnin to be rid of a bad mistake. But the creatur cannot be wholly vile when instead of torturin monkeys it takes thought for the opossum".

It would not be right to quote from a century old report without speaking of all that is done an has been done during many years for the car and health of animals by the great London Society and in doing this, for the education and happines of our people. But the change of which I hav spoken is most deeply impressed on those wh remember, as many of us do, the misdirecte hours in youth when birds were shot in our garden and brick traps made to catch them. I feel sur that those who did these things are not essentiall different from their children and grandchildre who have grown up in a kinder atmosphere.

I must not occupy more time on a subjec which to some may seem inappropriate, but it i bound up with education in its true sense— leading out—and if, as Ray Lankester said a York, and we are all coming to believe, the hidde powers within *are* inherited while the results o their development are *not*, then there is no easin of the burden with the passage of time, but eac generation afresh must bear the heavy responsi bility of conducting this development in the bes way so that its successor may be able to meet th changing and, at this time, the increasing needs The relationship between the powers within an their development was suggested in arresting word by the late Prof. Scott Holland: "To say that man cannot be made good by Act of Parliamen is such an obvious truth that people forget wha an outrageous lie it is!"

International Peace

Thoughts on the development of these hidde powers by the educating influence of social enviro ment, suggest the greatest of the problems b which we are faced—the end of international wa Michael Foster, in his address at Dover in 189 after speaking of progress in the material of wa fare was led to believe that, "happily, the ver greatness of the modern power of destruction already becoming a bar to its use, and bids fair may we hope before long?—wholly to put an en to it; in the words of Tacitus, though in anothe sense, the very preparations for war, through th

character which science gives them, make for peace". In his concluding pages he expressed the hope that the brotherly meeting between the English and French Associations at Dover and Boulogne might be looked upon as a sign that science, by nobler means than the development of armaments, was steadily working towards the same great end. In a time of still greater need and perplexity, may we not, in the same hopeful spirit, look upon the recent visit by which members of the French Association have honoured us, and feel strengthened in the belief that the great end will be reached.

There are, I know, very many people who look upon the Great War with later wars and rumours of wars as the close of Michael Foster's dream. The words in which Sir Arthur Schuster concluded his address at Manchester in 1915, and Sir Edward Thorpe at Edinburgh in 1921, indicate, I hope, that the British Association does not thus despair, and in this belief I bring before you a passage from the far earlier address which Sir Richard Owen delivered to the twenty-eighth meeting at Leeds in 1858—a passage which makes a special appeal at a time when the British and American Associations are confidently hoping to strengthen still further the bonds of sympathy and mutual appreciation by which they have been happily united for so many years.

Referring to the trans-Atlantic telegraph, Sir Richard said :

"We may confidently hope that this and other applications of pure science will tend to abolish wars over the whole earth ; so that men may come to look back upon the trial of battle between misunderstanding nations, as a sign of a past state of comparative barbarism ; just as we look back from our present phase of civilization in England upon the old border warfare".

Confident words inspired by the forging of a new link between the two great English-speaking nations. Nearly eighty years have passed since they were spoken, but with all the terrible disappointments there has been great progress, and a time will surely come, and may it come quickly, a time which shall prove that the visions of the young and the dreams of the old were prophetic of a glorious reality.

[1] "Early Science in Oxford", vols. 1–11.

[2] "The Natural History of Oxfordshire, being an Essay toward the Natural History of England", by Robert Plot, D.D. Printed at the Theater in Oxford. 1677. Dedicated To the most Sacred Majesty of Charles the Second, King of Great Britain, France and Ireland, Defender of the Faith, etc. (pp. 118–122).

[3] "Life and Letters", vol. 1, p. 157.

[4] Report, British Association, Centenary Meeting, 1931, p. 78.

[5] Report, British Association, 1905, pp. 514–518.

[6] Report, British Association, 1921, pp. 413–415.

[7] "Science and the Faith", London, 1889, pp. 222–235.

[8] "Life and Letters", 1900, vol. 2, p. 379.

[9] From a letter of August 10, 1894, printed in the *Jesus College (Oxford) Magazine*, for Lent Term, 1928 ; and reprinted in *Hope Reports*, vol. 16, 1929, No. 3, p. 6. (Privately circulated to many scientific libraries.) Huxley's letter of August 18, 1894, to Lewis Campbell ("Life and Letters", vol. 2, p. 379) refers to the same subject.

[10] The lines are quoted from the first part, published 1846–48.

[11] Darwin-Wallace Celebration of the Linnean Society of London, 1908, pp. 6, 7.

[12] "The Origin of Species. A New Song". In "Songs and verses, social and scientific", by an old contributor to Maga. Edinburgh, 1868, 2nd Ed.

[13] *Ibis*, October, 429–433 (1859).

[14] Report, British Association, 1906, pp. 26–27. The conclusions here quoted had been communicated to Société de Biologie of Paris in 1899 (jubilee volume) and were reprinted in NATURE, **61**, 624–625, (1900).

[15] Report, British Association, 1895, p. 734.

[16] NATURE, **51**, 127 (1894) ; Report, British Association, 1906, pp. 29, 30.

[17] *Trans. Roy. Ent. Soc., Lond.*, **85**, 131 (1936).

[18] *Proc. Roy. Soc.*, B, **106**, 83, pl. v (1930) ; *Proc. Ent. Soc. Lond.*, **5**, 14 (1930).

[19] Report, British Association, 1931, p. 77 and references quoted.

[20] *J. Linn. Soc.* (Zool.), **26**, 465, pl. 30 (1898).

[21] "Evolution", A. Franklin Shull (New York, 1936).

[22] Walsh and Riley, *The American Entomologist*, St. Louis, Mo., 1, 189 (1869).

[23] *Trans. Linn. Soc. Lond.*, **23**, 495 (1862).

[24] Riley, "Third Annual Report on the Noxious . . . Insects of . . . Missouri" p. 142 (1871).

[25] Poulton, "Charles Darwin and the Theory of Natural Selection" p. 292 (1896).

Summaries of Addresses of Presidents of Sections*

Noise and the Nation

THE programme in Section A (Mathematical and Physical Science) this year is largely devoted to some of the social and industrial developments of applied physics. The president of the Section, Dr. G. W. C. Kaye, has broken with precedent in giving an address of an experimental character, and in choosing an acoustical subject for the first time in the history of the Section, extending over a hundred years.

Acoustics was long the Cinderella of the physical sciences, but with the coming of the gramophone, radio, broadcasting and the talking pictures, and the popularizing of the telephone, the commercial value of applied acoustics must now run into very large figures. Sound has become a marketable commodity, the cultural and political developments of which, particularly in regard to broadcasting, it is not easy to envisage. The literature is immense and the terminology large and extensive, as may be gathered from the recently published acoustical glossary of the British Standards Institution.

Simultaneously with these developments in applied acoustics, the nation has begun to take notice of the growth of noise—a by-product attributable in great part to an increasingly mechanized civilization. Much research is being carried out to meet the public demand for greater protection against the noise nuisance of to-day, chief interest being probably centred in the noises on the road and the noises experienced in modern buildings, which are admittedly not so quiet as those of a generation ago.

It is only within the last few years that practicable instruments have become available to measure and analyse sounds and noises, though it cannot be said that finality in these directions has been reached. In cases of annoyance caused by noise, experience indicates that while the composition and the psychological aspects are not to be ignored, sheer loudness is often a determining factor. Particular attention has therefore been devoted to the subjective scale of loudness and its unit, the phon, and the associated unit of energy or pressure level, the decibel. An important step was taken this year when both were adopted as international units by some thirteen nations in Paris.

The study of the general question of noi transmission, particularly in buildings, is mo complex than might be imagined, and some of th major difficulties are not yet completely resolve For the purpose, facilities such as are provided b the 'sound-proof' acoustic laboratories at th National Physical Laboratory have proved to b necessary. *Inter alia*, it already appears tha special designs of double floors, double walls an double windows, which have been evolved, for material contributions to noise-abatement buildings. The degree of public interest in th general question is illustrated by the wide variet of noise problems submitted to the Nation Physical Laboratory during the last few years for example, the mitigation of the noises aeroplane cabins and engine-testing factorie trains, ships, tube railways, motor-cars, moto cycles, motor-buses, motor-horns, pneumat drills, printing works, transformer sub-station cathedrals, assembly halls, business offices, flat miniature rifle ranges, building operations an so on.

The growing volume of road traffic and the eve increasing speed and acceleration of individu vehicles are major contributory factors to th problem of road transport noise. A Department Committee of the Ministry of Transport w appointed in 1934 and has since published thr reports. Loudness measurements, many tho sands in number, were conducted for the Com mittee by the National Physical Laborato on the overall noise of some hundreds of moto vehicles, both new and old. The Committ has proposed noise limits, which, while maki very moderate demands on most types of vehic would, by ruling out the flagrant offenders, he to ensure a standard of acoustical decency the roads of Great Britain. More recentl the Committee has submitted a report on moto horns.

Organized steps are being taken in Gre Britain to further the abatement of the ma types of unnecessary noise. There is now a good list of 'silent' appliances in everyday life, thou it is evident that as regards many commerc machines and processes we shall have to put with second-class expedients for the prese It is evident, however, that the finding practicable solutions to the many ramifications the noise problem would be welcomed by almo every section of the community.

* The presidential address, and addresses by the sectional presidents, are being published as "The Advancement of Science, 1937" (Nottingham: B.A. Reception. London: Burlington House.) 3s. 6d.

Researches in Chemotherapy

CHEMOTHERAPY, which forms the subject of Dr. F. L. Pyman's presidential address before Section B (Chemistry), may be regarded as the treatment of disease by chemical substances, which have been shown by biological methods to be relatively much more toxic to pathogenic organisms than to human or other animal hosts.

Chemotherapy was developed by Paul Ehrlich, and its most outstanding achievement has been the introduction of the arsenic group of spirochæticides.

In the field of bactericides, the introduction of phenol as an antiseptic by Lister in 1867 has led to the study of many derivatives of phenol. Recently systematic studies of various homologous series of phenols have resulted in the introduction into medicine of hexyl-resorcinol and amyl-*m*-cresol, the latter having a Rideal-Walker coefficient of 280.

The chemotherapeutic investigation of amœbicides was greatly facilitated by the *in vitro* test for amœbicidal efficiency developed by Dobell and Laidlaw. Using this test, Coulthard studied a series of alkyl derivatives of harmol prepared in Messrs. Boots' laboratories and showed that peaks of bactericidal efficiency were reached at butylharmol for *B. typhosus* and at amylharmol for *S. aureus*, whilst peak amœbicidal activity was found in *O*-*n*-nonylharmol. Salts of members of this series were, however, very sparingly soluble in water, and in order to obtain more soluble compounds the corresponding dialkylamino derivatives were prepared and their amœbicidal activities compared with that of emetine. Although the most active member was not as active as emetine, it had several times the activity of *O*-*n*-nonylharmol and it was suspected that the harmol residue might not be the important contributor to the amœbicidal properties of the molecule and that the dialkylaminoalkyl group might play an important part. This led through various intermediate stages to the preparation and study of a series of tetraalkyldiamino paraffins and of these αx-tetra-*n*-amyldiaminodecane was found to be the most efficient. For brevity, the compound is referred to as T.A.D.D.

The preceding results had shown that, when tested by the Dobell and Laidlaw technique, T.A.D.D. was the most active amœbicide so far prepared. It now became necessary to compare the efficiency of this compound with that of emetine under conditions as similar as possible to those found in the intestine of a dysenteric patient. When tests were carried out under these conditions T.A.D.D. was found to be more active than emetine. As originally pointed out by Ehrlich, the therapeutic value of a substance is a function of its toxicity to both parasite and human host. It became necessary, therefore, to determine the relative toxicities of T.A.D.D. and emetine to mice. The results of such a test showed T.A.D.D. to be from one third to one eleventh as toxic as emetine, depending on the method of administration.

T.A.D.D. had thus a greater *in vitro* amœbicidal activity and was less toxic to mice than emetine. These results appeared to justify the clinical trial of the compound in the treatment of amœbic dysentery.

Such a trial was carried out by Prof. Warrington Yorke, at the request of the Therapeutic Trials Committee of the Medical Research Council. Unfortunately, T.A.D.D. proved to be too irritant for parenteral administration and it was not sufficiently active to be of any real value when given orally.

Whilst this investigation has not yielded a compound of clinical value, it has resulted in the accumulation of valuable data which will be of value in further work on this subject.

The account of such an investigation indicates the enormous amount of chemical and biological team work involved in attempts to evolve new drugs for the treatment of disease.

The Glaciation of the Midlands

IN his address to Section C (Geology), Prof. L. J. Wills discusses the Pleistocene history of the West Midlands with the object of discovering how many glaciations are represented, and of linking these up with the better-known sequences of East Anglia.

It has long been recognized that the boundary between the 'Newer' and 'Older' Drifts crosses the district from Church Stretton through Bridgnorth to Wolverhampton. Prof. Wills devotes attention mainly to the Older Drifts, which have undergone enormous denudation in the vales but have in varying degrees survived on the Midland Plateau and on watershed areas. The evidence of the former great extension of the present outcrops is scattered, but is *en masse* sufficient to allow the assumption that the vales of Severn and Avon were ice-filled during the older glaciations, though it must be realized that they were far shallower then than now.

In the Midlands three principal types of drift can be recognized: *Irish Sea* in the north-west, and belonging to the Newer Drifts; *Western* or *Welsh* on the Midland Plateau (this occasionally contains Irish Sea boulders, and in the Trent

valley is *Pennine*, not Welsh, in origin); *Eastern* to the east of the Warwickshire Coalfield and in the Avon vale as far down as Stratford and possibly as far as Tewkesbury. The Eastern Drift is a continuation of the Great Chalky Boulder Clay of the Eastern Midlands and East Anglia.

Analysis of all the available evidence leads to the conclusion that the Older Drifts of the Midlands are the products of two separate cold periods. In the First Glaciation, ice moving from the north-west brought Welsh and Pennine material. The Welsh lobe travelled down the Severn vale, and its marginal drainage was probably responsible for the siting of the present Lower Severn valley. Some evidence of the First Interglacial has been obtained near Coventry and Rugby, and in Leicestershire. In the Second Glaciation the 'Great Eastern Glacier' of Harmer was the dominant feature, but side by side with it was an important Welsh Ice Sheet covering the northern part of the Severn vale and much of the Midland Plateau. The influence of these two lobes can be seen in the distribution of glacial and river drifts, and in modifications of the drainage. The retreat stages of the two ice sheets can only be traced in very general outline; the indistinctness is a measure of the antiquity of the events.

The Second or Great Interglacial which closed the period of the Older Drifts and led up to that of the Newer, is represented in the Midlands in two ways: first, by vast denudation which allows us to designate the Older Drifts as 'high-level' in contrast to the 'low-level' terraces of the valleys that resulted from the erosion; and secondly, by the Kidderminster Terrace of the Severn and No. 4 Terrace of the Avon, the distribution of which makes it improbable that ice has since invaded the Midlands beyond the limits of the Irish Sea Drifts.

The Third Glaciation is represented in the north-west by the Irish Sea Drifts, and elsewhere by the Main Terrace of the Severn and its correlatives in all the tributaries, and by taele-gravels and melt-water flood-gravels. Only brief reference is made to the outstanding influence of this glaciation on Midland physiography through the establishment of the Iron Bridge diversion of the upper Severn with the resultant rejuvenation of the river due to its increased volume. This and the evidence for a fourth glacial episode can only be touched upon; and no attempt is made to deal with the latest events, the primary object being to establish the existence of two glaciations within the period of the Older Drifts, and the correlation of the second of these with the Great Eastern Glaciation of East Anglia.

Selective Action of Mortality

FOR the reasons that they furnish relia information concerning the progress o vast experiment which we are conducting w ourselves as the experimental material, and a that they can be appreciated only by such as bring to their examination knowledge deri from a comparative study of different forms, v and domesticated, in the open and under conditions of controlled experimentation, attention of the zoologist is directed by P F. A. E. Crew in his presidential address Section D (Zoology) to the facts and observati relating to the human sex ratio.

It is easily demonstrated that to be born i far more dangerous adventure for the male t for the female, and that indeed the true recipe longevity is to be born a girl. It is equally rea shown that numerical equality of the sexes i population such as ours exists only among th individuals who belong to the ages that associated with the reproductive prime. Am the 0–15 year olds there are more males t females. Among the 20's and over there more females than males, and the female numer preponderance increases with increasing age, that among the 85's and over there are twic many women as men. In a democracy such as o in which sex is supposed to be disregarded, political power of women is not at all commensu with their relative numerical strength.

This swing in the sex ratio from high to v low is known to be the result of a sexually selec mortality which operates to the disadvantag the male both before and after birth, and since severity of this mortality is profoundly influen by a number of environmental agencies, i possible to use the sex ratio as a measure by wh a society may assess the quality of its architect

It can be shown that there is nothing uni about the human sex ratio, and that the fo which tend to distort it are identical with th that produce the same results in other for When male is contrasted with female, it beco clear that the greater fragility of the former r be regarded as an indication of his relative lac importance in respect of propagation. Efficie and economy would seem to be observed by removal of the male when he has served purpose. Through selection the sex ratio become adjusted to the conditions that exist i population, and it is possible to construct a thou model of a purely genetic mechanism through workings of which the size of the primary sex r is brought into harmony with the amount mortality due to the action of sex-linked gen lethals, to sex-limitation in the expression

disadvantageous characters, and to the effects of sex dimorphic physiological qualities. The relation between the size of the primary sex ratio and the amount of mortality, both pre-natal and during adolescence, is such as to lead to the establishment of an optimum reproductive sex ratio among those who, in respect of purely biological properties, are newly equipped for ardent reproduction.

Changing Distribution of Population

IN noting that four chief populous regions, in 'Europe', the Far East, India and eastern North America, now contain three fourths of mankind on one eighth of the land area of the world, it is pointed out by Prof. C. B. Fawcett in his presidential address to Section E (Geography), that the peopling of the fourth of these by the great European migration of the last two hundred years is the only shift of population of world magnitude recorded within the historic period. The south temperate lands even now contain barely a fortieth of the world's population; and the other considerable migrations are merely oscillations of the margins of the four great populous regions.

A more important change is the recent growth of great conurbations. In 1801 London, with 950,000 inhabitants, was the only city which approached a million. Now there are about sixty million-cities, a dozen of which exceed five million, and which together include a twelfth of mankind. The number and population of these great conurbations are growing; and if this trend were to continue unchecked for another two or three generations, it would give a world in which a majority of the inhabitants would dwell in two or three hundred such cities.

Within the great populous areas there is also a development of a few small areas of maximum concentration, where great conurbations tend to cluster. Three such areas are noted. The chief is in Western Europe. Part is in England, where it stretches across country from South Lancashire and West Yorkshire to Essex and Sussex and gives this belt of country a mean density of three thousand persons per square mile. It is continued beyond the Strait of Dover to the Rhineland. A second such area, of similar extent but half as populous, lies along the coast of the Middle Atlantic States of the United States of America, where a fifth of the population dwells on a hundredth of the area of the country in an urban zone from Boston to Washington. A third is appearing along the lower Yangtze in China. There is as yet no comparable development in India.

Somewhat more recent in its development is the widespread retreat of population from 'regions of difficulty', marked by the diminution of population in all the highland areas of Britain and Europe and in the semi-arid parts of Australia and North America. Both changes are ascribed mainly to improvements in agricultural science and in transport, which make the cultivation of such marginal lands both less necessary and less attractive. This change is aided by the check to the natural growth of population in all the lands of Western civilization; for the rapid increase in numbers which has been a dominant fact of human life during the past two hundred years, during which mankind has increased from about 500 millions to some 2,000 millions, is now coming to an end. But there is as yet no indication that this check to growth is affecting the trends of movements discussed, which result from the development of applied science.

Economic Research and Industrial Policy

THE rationalization and planning movements, unofficial and official, that have in recent years swept over the industrial world involve a number of practical policies that must be separately discussed if their efficiency is to be scientifically assessed. In his presidential address to Section F (Economic Science and Statistics), Prof. P. Sargant Florence reviews recent realistic research into the policies of the siting, size and scope of industries.

A policy of siting or location has been urged upon the Government in connexion with the redevelopment of the depressed areas. Economic research has had to devise methods of measuring the degree of localization of all industries in the various regions of England and Wales and is now nearer a position to specify what industries can be developed where employment is still stagnant. In general, the extreme localization of industries at the source of fuel or of the existing supplies of skilled labour seems to have reached a limit, and the proximity to the home market to have become relatively more important.

A policy of larger-sized plants, firms or areas of control is usually implied by rationalization and planning. Recent statistical research into prevailing sizes, the trend in sizes, and comparative profits and costs in Britain, Germany and the United States does not confirm the theory that limits to size have been reached owing to organization becoming unmanageable. Size, however,

varies characteristically with different industries, and depends largely on their degree of mechanization and localization. A particularly pressing problem is the large number and the small size of middlemen and shops in the distributive trades. The lack of any official census of distribution for Britain makes calculations difficult, but it seems probable that there is one retailer for about every ten families, and, even for single commodities like tobacco or confectionery, an outlet for every twenty to thirty-five families! This appears excessive, since the smaller the sales turnover of each retailer the more profit he must charge per unit of sales to obtain a given income for himself. This raises prices and leads, in a vicious circle, to yet lower turnover.

Policies involving the scope of industry are those 'integrating' various processes, products or services under the control of one organization, or specializing upon and standardizing certain varieties. Standardization, as against integration, allows of mass production and of possibilities of increasing returns. There are difficulties in measuring and comparing the scope of plants or firms, but several recent experiments in connexion with plans of rationalization have shown the great increase in efficiency that specialization and narrowing of scope may achieve within one plant.

Policies of site, size and scope are interrelated. Large size is more manageable if of narrow scope, but difficult if sites must be scattered among the consuming population owing to the intransportability or the servicing requirements of the product. Further research along realistic and statistical lines is urgently needed if public policy or the policy of private firms is to achieve greater efficiency and save wastes of materials, mechanical power and man-power.

Research in Engineering

IN his presidential address to Section G (Engineering) Sir Alexander Gibb deals with the importance of research in the history of engineering. Recognition of this fact has been of very slow growth.

Organized research was nearly unknown until the end of the nineteenth century. Early progress was due almost entirely to individuals and learned societies, such as the Royal Society, working often in an atmosphere of public ridicule. Though the British led the way in Government recognition about the middle of the nineteenth century, it was largely due to the German example after the Franco-German War that the true value of research to the nation and industry was realized. The Reichsanstalt and other testing laborator had a direct effect on British policy which show itself in the setting up of the National Physi Laboratory in 1900, leading later to the Depa ment of Scientific and Industrial Research, wh is now the focus, linking together all resea going on in Great Britain.

The year 1900 is a boundary mark in the histo of research in Great Britain. The National Physi Laboratory (1899) and the Engineering Standa Association (1901) were born then. The first, w the Department of Scientific and Industr Research, of which it became a part in 1918, grown into a body employing a staff of more th 1900 scientific workers; while the Engineer Standards Association has become an imme organization of no fewer than 870 committees w 4850 members.

Engineering, which started as an art, is now applied science; and we look on scientific a industrial research as an essential factor in national existence. In one generation our attitu has completely changed, from individualistic eff to co-operation and co-ordination. To-d national research departments, industrial resea laboratories belonging to great firms or industr research associations, scientific institutions a universities and technical colleges are the ch agencies which carry out the work, often in cl co-operation one with another.

In the United States, the Dominions, and on Continent progress and development have b equally revolutionary; and more so in some the totalitarian States, where all research centralized under State control. In Great Brita though co-ordination and co-operation have d much to link together the various elements, still lack a general national plan. Some form affiliation to a central controlling body is inevita if we are to avoid overlapping and duplication w their attendant waste of energy, time and mon This, incidentally, is especially necessary where publication of the results is concerned. At pres these are scattered in far too many differ periodicals. A central clearing-house for enginee information is an urgent need.

One note of warning is sounded by Sir Alexan The effects of research may sometimes be sudden and revolutionary. Obsolescence may too rapid, and vested interests may be tempted buy up and suppress new inventions in or to save the loss their exploitation may involv already operating plant. It would, however, a short-sighted policy to restrict our enthusia for these reasons. He is satisfied that at moment in the engineering world there are outstanding questions, the co-ordination of ef and the promotion of intensive research.

Assam Origins in Relation to Oceania

DR. J. H. HUTTON in his presidential address to Section H (Anthropology) deals with certain aspects of the culture of the Assam hills which suggest a close association in origin with those of Oceania, and which may therefore throw some light on the general problem of the succession of cultures in the Indonesian archipelago.

The link between the cultures of the Naga Hills and of Melanesia has been brought into prominence by recent work of Prof. Henry Balfour, while the work of Dr. A. C. Haddon and others in Borneo and New Guinea affords instances enough to show a line of related cultures connecting Assam with the islands of the Pacific. To determine, however, the nature of that relation, it is advisable to concentrate on particular areas, and for this purpose the Fiji Islands, the Marquesas and Madagascar are chosen as being three widely separated points with inhabitants of varied race and culture in the Oceanic area.

In the case of the Fiji Islands, parallels with Assam are indicated in practices connected with war, head-hunting and human sacrifice, with the cult of the dead, and with beliefs in regard to the soul, and in items of material culture, in particular in regard to the Fijian national game of *veitingga*, and in some psychological aspects. In the Marquesas Islands a similar series of parallel customs is found, particularly in the practices associated with head-hunting; for example, in the separate disposal of the mandible and in the use of stone. In Madagascar a rather different parallel complex is found, though here again there is much similarity in the use of stone and in the treatment of the dead.

An important feature of Naga culture is the use by certain tribes of slit wooden gongs or xylophones. The cult associated with these gongs is in many ways closely parallel to canoe cults of Melanesia, and it is suggested that the Naga "canoe-gong" is a dug-out canoe by origin which has survived, as a musical instrument and a fertility fetish, a change of environment which inhibited its use as a canoe. The intimate association of the canoe-gong with head-hunting is particularly noticeable, as the ceremonial is very similar to that associated with the canoe in Melanesia, the main difference being that in the latter case the association is natural, since the canoe is the means of obtaining the victim, whereas in the Naga Hills there seems no direct reason for associating the "canoe-gong" so closely with the taking of heads. Further, the canoe can be, and is, used as a gong for certain purposes in the Pacific, where it is sounded by means of the handles of the crew's paddles. A somewhat similar practice is found in Manipur, and it is suggested that the dumbbell-like implement used for pounding on the sides of a canoe-gong is a degenerate form of a paddle formerly used for propelling it as well.

The general conclusion is that not only has the culture of Assam been influenced by a stream of migration from Indonesia north-westwards, but also that in both areas, as in Oceania, a series of corresponding and related cultural strata are to be found in an amalgamated form, even if the actual site of amalgamation was elsewhere. It is suggested that such a site is to be sought for in or near the Indian archipelago.

Heat Production, Nutrition and Growth in Man

IT is almost a truism to say that the amount of money spent on medical research has greatly increased of recent years; but, as Dr. E. P. Poulton shows in his presidential address to Section I (Physiology), the application of research to medical practice has lagged behind, especially where newer and expensive apparatus is concerned, largely because of the straitened circumstances of the voluntary hospitals. A pious benefactor could accomplish much with a comparatively small sum of money if he helped the voluntary teaching hospitals in this respect, as when once the medical student—the future doctor—has become accustomed to a new method or new apparatus its spread through the country cannot be so long delayed.

Direct calorimetry means the determination of the heat in a calorimeter. Indirect calorimetry means its calculation from the oxygen absorbed and the carbon dioxide given out. At present indirect calorimetry is based on the theory that the respiratory quotient (volume of carbon dioxide given out divided by volume of oxygen absorbed) indicates the proportion of fat and carbohydrates being burnt in the organism. A comparison of the figures for heat, oxygen and carbon dioxide obtained by Benedict and Carpenter and Du Bois and his colleagues, shows that there is a fundamental error in the present method of indirect calorimetry.

The theory which best explains the facts is that carbohydrate and fat are always burnt in a fixed proportion in the organism, and that when the respiratory quotient rises there is simultaneous conversion of carbohydrate into fat,

and with a fall of respiratory quotient vice versa, as indicated by the following equation, which is based on Cathcart and Cuthbertson's analyses for human fat, and from which it follows that every litre of oxygen used in the conversion is equivalent to 3·93 calories :

$$4C_{27}H_{50}O_4 + 42O_2 \rightleftarrows 18C_6H_{10}O_5 + 10H_2O.$$

A quantitative proof of this conversion (1) during basal metabolism tests, (2) after food and (3) during exercise on a carbohydrate diet is obtained from the fact that, after allowing for the heat, oxygen and carbon dioxide required for the combustion of carbohydrate and fat in a fixed proportion, the equivalence of the remaining oxygen and heat is very close to this figure.

Since these conversions are ephemeral under basal conditions, the basal metabolism should be measured by the carbon dioxide alone, and this means a new definition of basal metabolism ; an experimental method is described. It is argued that the proper standards of metabolism in adults depend on the weight and age of the individual, and that the height should not be brought in as a separate factor, as in Du Bois's height–weight formula. In babies, however, height is more important than weight, because some individuals are heavy, probably from the retention of fluid due to hypothyroidism. There are three nutritional periods in childhood : the first, up to a length of 29 inches (1 year), when the baby puts on fat and the carbon dioxide increases rapidly ; the second, from 29 inches to 41½ inches (5–6 years), when the excess of fat is lost and the metabolism only increases slightly with the weight ; and the third, from 41½ inches upwards, when the weight and carbon dioxide increases steadily. It is shown that the relation weight to age is not a satisfactory standard of growth ; but only height and age, the 'cumulative growth curve'. Although growth is greater now than it was fifty-six years ago, and children of better-class families are taller than those from poor families, the average general nutrition of the child in these groups, represented by the relation of the logarithm of the height to the logarithm of the weight, remains constant, and it is suggested that the calorie intake is sufficient ; but that certain growth factors are deficient among the poorer classes.

Tests for Colour Defects

DR. MARY COLLINS in her presidential address to Section J (Psychology) discusses some of the tests used in the diagnosis of colour defect. A brief reference is made to total colour-blindness and blue-yellow blindness, but they have neither the same theoretical nor practical impo tance of the third form of the defect, namely, re green blindness. The incidence of this latter ty in the male population is quoted in recent literatu at figures ranging generally from 5 per cent 12 per cent, as contrasted with the figures usual given of 3–4 per cent, her own results giving 7·5 p cent. It does not necessarily follow that the in dence of the defect is increasing, but the indic tions are that the detection of the defect is nc more accurate owing to the improvement of te material.

It is gradually being realized that many degre of red-green colour-blindness exist. In its extrer form there is complete blindness to red and gree but in a milder form blindness to these two colou is only partial. Red and green can be discriminat if conditions are favourable, but when unfavou able conditions exist, as in mist or fog, the colours are confused. The anomalous trichroma forms one type of the partial colour-blind. T suggestion is made that provided the colour pe ception so far as red and green are concerned a sufficient number of individuals could be e amined, a continuous series ranging from norm that is, perfect perception of these colours, extreme red-green colour-blindness might be foun The intermediate forms, which although not total blind to red and green show great deviations fr the normal, are very important.

Tests for colour defect fall into two categorie in one type of test, transmitted light is used, the other reflected light. While the former regarded as the more fundamental, the latter c be of great service for quick diagnosis of colo anomaly. As a spectrometric examination is n always possible, either some form of lantern te or pigment test is substituted. Both are essent in posts where lack of accurate colour discrimin tion involves danger to the community. The form using coloured lights, brings conditions nearer practical conditions. In other posts, however, pigment test is all that is essential. To this en a combination of the Ishihara test, the first thr tables of the Stilling test and Schaaff's mos plates is recommended.

A detailed examination of a number of pigme tests has been made. The responses of a group colour-blinds have been compared with t responses of a control group of individuals wi normal colour vision. In this way an evaluati of the tests has been made possible. Some the tests, too, have been submitted to fil analysis.

Inconsistencies have appeared. It may be th the discrepancies revealed are due to numero deviations from the normal in colour vision, a that we are not dealing with linear variations

degree, but with multidimensional variations. A wide new field for investigation is thus disclosed, the working of which may yield valuable results for the whole theory of colour vision.

Education and the Modern Study of Plants

THE subject of Prof. E. J. Salisbury's presidential address to Section K (Botany) is the modern study of plants in relation to education. There are several misconceptions with respect both to the contacts and to the contents of botanical science. Despite the vastly enlarged content of botanical knowledge since it was regarded as a harmless and elegant occupation for the female sex, the general conception of botany has remained much what it was then. The high value of botany as an educational subject and indeed its absolute necessity in any system of real cultural development is an aspect that botanists have failed to present and emphasize. This is partly the outcome of the growing obtrusion of the more technological aspects in this as in other subjects ; a trend which is making itself felt further and further back in the student's training, at the expense of general education and culture. Here, as elsewhere, too much attention is paid to the acquisition of mere information, too little to the principles which are involved.

Our educational methods are too often divided in their allegiance between the provision of a liberal culture that will make for the greatest happiness of the individual in terms of mental contentment and an abiding resource in later life, and the technical equipment of the student for the earning of his daily bread. This emphasis on erudition has been perhaps encouraged by the universities through the fact that a sufficiently broad basis of scientific knowledge is not insisted upon before specialization begins, and that in the appointment to academic posts too little attention is given to capacity as teachers.

The merits of botany from the cultural point of view are many. It provides perhaps the best medium for training in accurate observation, it is the foundation of a vast extent of human activity and the basis of a large and essential part of every human environment. Its very extent, however, as indicated by enumeration of its diverse branches of taxonomy, morphology, anatomy, cytology, mycology, palæobotany and plant geography, on the descriptive side, and the experimental aspects of ecology, physiology, bacteriology and genetics, indicate the breadth of the botanical field, whilst the applied aspects of agriculture, horticulture, pomology, sylviculture and plant pathology show the great contribution that botany can make to the well-being of the human race as well as to the enrichment of the mind. This diversity tends towards detachment of interests and specialization which should be accompanied by greater co-ordination. The accumulation of data in these varied directions of inquiry will only fulfil its purpose if the many threads are continually woven into a single fabric of knowledge.

Herein lies the particular cultural value of the synthetic approach which we term ecology. The study of the plant in relation to its environment not only brings together almost every aspect of plant study but also has a direct bearing upon many practical problems such as land utilization, the conservation of water supplies, or the selection and care of national parks.

The Informative Content of Education

MR. H. G. WELLS, in his presidential address to Section L (Education), directs attention to an aspect of educational science that has received perhaps a disproportionately small amount of attention in educational literature, the question of information. He leaves the physical and mental training of our modern populations aside, he contributes nothing to the discussion of language teaching, mathematics, the cultivation of literary appreciation, music, drawing and æsthetic training generally, and he concentrates upon the question of what a modern human being should know in order to play the part of a citizen, happily and adequately. What sort of *fact system* should be and can be established in a normal human mind under the conditions existing in a contemporary civilized community ?

Few people realize the restrictions set to the accumulation of knowledge by the exigencies of the time-table and the school-leaving age. When due allowance has been made for the other elements in educational work it is questionable whether we can allot more than six hours a week to imparting real knowledge (real, that is, as distinguished from methods of expression, etc.), or, assuming ten 40-week years, rather less than two thousand four hundred hours altogether in the school period of life. A vast amount of miscellaneous knowledge is, of course, picked up by talking, reading, observation and so forth outside the formal school scheme and we learn facts in vast variety to our

dying days, but this is uncorrelated stuff, and it is within the limits of these two thousand four hundred precious hours that a sound framework of general knowledge must be established, if ever it is to be established in the growing mind.

At present we waste a considerable amount of this meagre allowance in imparting useless and unedifying information or information of secondary importance. We need a much more stringent economy in this respect and a more rigorous examination of what is included. The desire for knowledge, unless it is perverted and discouraged, is a natural impulse in the developing human being, and the informative side of educational work should be based on the natural curiosity of the child and should stimulate, develop and gratify it. The curiosity of the child turns mainly upon inanimate things and what can be done with them, upon animals and (secondarily) plants and upon personal and then social reactions. Upon the systematic exploitation of these primitive divisions of curiosity our teaching of the facts of physics, biology and historical and social sciences must rest. By a careful selection of topics it is possible in the period up to the dawn of adolescence to impart clear conceptions of material science, making for mechanical understanding and competence, and a vision of the history of life upon the earth and of human history and human conditions, hygienic, physiological, geographical and political, sufficient for adequate citizenship without any killing of the spirit of inquiry.

A much more realistic and serviceable knowledge than is generally attained, of economic life and of the legal conventions of property and of the process of finance which dominate our everyday lives, is possible before the school-leaving age, but it is possible only through the stringent elimination of any irrelevant matter and of any matter which distorts the general picture. The major fault of the knowledge system we build up to-day in the general mind is its lack of proportion. The historical intelligence, the political mind of the contemporary European citizen is a sort of hunchback mind, in which the hole-and-corner facts of the national history and the petty details of the Jewish tribal records loom, preposterously exaggerated. The necessity of a drastic modernization of the historical outlook has been shirked too long—with disastrous results to the world. History, the backbone of our fact system, needs to be straightened and that hunch removed.

Under modern conditions schooling is only foundation work. There is now no end to education throughout life. The primary fact system passes insensibly into a vast variety of technical learning and adult culture and so upward at its highest levels to the knowledge evoked by original inquiry and creative work. The proportion of those who contribute by observation and criticism to the common stock of knowledge and to its sifting and organization is likely to increase very considerably in the future. Mass observation as it is being developed by Harrison and his group may have many important effects upon the public mentality.

State Intervention in Agriculture

IN his presidential address to Section M (Agriculture), Mr. J. M. Caie first shows the position occupied by agriculture in the State, by giving statistics of areas, holdings and populations, the output of food from our farms, and the contribution they make to the food consumption of the people. Corresponding figures for Denmark and Norway are given for purposes of comparison. Specially notable facts are that the number of persons per acre of cultivated land in Great Britain, 1·5, is relatively high, while the proportion of the population engaged in British agriculture, about 6 per cent, is very low, as compared with 29 and 30 per cent in the other two countries; that the products of animal husbandry represent about 72 per cent of the output of our land; that the value of the output per acre of land is about £8 in Great Britain and Norway, and £11 in Denmark, while the annual output per person in British agriculture is £200 and in Danish £150; that in respect of most products, except liquid milk, oats and potatoes, we require to import very considerable quantities; and that agriculture buys from other industries goods valued, roughly, at twenty to thirty million pounds a year.

State intervention may be divided into three categories: (1) compulsion, enforced by penalties; (2) provision of means for voluntary action, with powers to compel minorities; (3) assistance—financial, advisory, protective, etc. Present measures of control are such as relate to annual statistical returns, contagious diseases of animals, destructive insects and pests, live-stock breeding, agricultural wages, etc. Under the second category comes the recent marketing legislation, while under the third category particular mention may be made of State grants for agricultural education and research. In 1912 these amounted to £100,639 per annum, whereas in 1936 the corresponding figure was £765,339. During that period the only significant increases in the average yield per acre of our principal crops were about 4–5 bushels of oats and half a ton of potatoes. But many progressive farmers could show increases in excess of

the general average, and the effects of improved methods are also to be found in reduced costs of production.

Statistics suggest that British agriculture at present falls short of producing as much home-grown food as is possible and desirable for the nutrition of the people and of affording employment on the land to as many persons as is reasonably practicable. As the output per unit of agricultural labour is steadily rising, increased production may not necessarily cause increased employment, but on the other hand it will probably be long ere the large-scale mechanized farm is normal in Great Britain. Two million acres have gone out of arable cultivation since the Great War, and increased production is at present a question of making up leeway in land and people rather than of settling men on new holdings.

The amount of assistance afforded by the State to agriculture indicates a possibility that, sooner or later, greater control may be exercised over the farmer's methods and the quantity and quality of his products. Such measures might raise questions as to insurance against loss, limitation of profits, control of rent, wages, etc. If it were the permanent policy of the State to support agriculture, it might be desirable to survey the whole industry, its place in the social and economic structure of the country, its present and potential capacity to meet the food requirements of the people, and its relation to international trade.

Lastly, one must consider whether in State aid, with its attendant shadow of control, lies the only hope for British agriculture. Some, at any rate, would wish to believe that our farmers, given a fair share of the home markets, could maintain their position by their own initiative, energy and resource, and with the help that education and research, both scientific and economic, can give. Otherwise there is at least a risk that our farming may become a hanger-on of the State, dependent on its bounty and subject to its commands.

Natural History Outlook

THE natural history outlook has changed so much during the present century that a new orientation is required if natural history societies are to keep their place as an integral part of the organization of science in Great Britain. In his presidential address to the Conference of Delegates of Corresponding Societies, Prof. James Ritchie directs attention to the changes which specialization has wrought in the opportunity of original amateur investigation, and suggests ways in which the societies might turn modern trends to good account.

Local societies perform useful work in spreading knowledge of scientific method and progress by their lecture programmes and discussions, but a higher aim is the gaining of new knowledge by regional investigations. The stable work which until now has kept the societies alive as contributors to science has been the building up of local lists. That outlet for the energy and enthusiasm of the local naturalist has become restricted owing partly to the exhaustion of opportunity for discovering rarities, and partly to the increasing subtlety of identification demanded by the modern systematist, so that the amateur has been frozen out of a province which for ages was particularly his own.

Two notable developments in the natural history outlook of the present century suggest ways in which the natural history societies may still retain their usefulness and contribute their quota to the advancement of knowledge.

In the first place, there is a marked tendency, due to the complexity of scientific problems, to forsake the individualistic form of research and to replace isolation by the collaboration of many workers organized as a team, whose joint labours converge upon some definite problem. In the second place, the emphasis of research has moved from morphological studies, which have passed far beyond the scope of the amateur, to the investigation of the animal as a living thing. A combination of these two tendencies offers a new outlook and a new field for the societies, the combination of organized co-operation or team-work directed towards the solution of biological problems. Much has already been learned by such methods, for example, about bird migration by organized co-operation in the ringing of birds in Great Britain and other countries, about the arrival and movements of birds and many other seasonal occurrences by the organized reports sent to the Royal Meteorological Society and published annually as a Phenological Report, about the migration of insects by the records sent to a committee of the South-eastern Union of Scientific Societies. Members of the societies, as individuals, already do good work in all these investigations, but more observers are required, and the societies could organize them, and could add enormously to the scope and scientific value of the inquiries of such organizations as the Bureau of Animal Population at Oxford or the Institute of Ornithology.

Should some societies lack in numbers of naturalists able to engage in such joint enterprises in biological problems, there are many other opportunities open to the individual naturalist for

the study of biological questions of real importance. Very little is known about the influence of weather and food supplies in Nature upon the development of mammals, birds, insects or, indeed, any other creature, and such studies, or the investigation of plant and animal populations in a circumscribed area, or of the changes wrought upon plant and animal groups by the interference of man, offer themselves as subjects for direct and not too difficult attack.

A third line of inquiry suitable for the amateur naturalist lies in simple experimental zoology, exemplified by such as Darwin's tests for the intelligence of earthworms, or Lord Avebury's experiments with bees and colours, or in more modern method Miss Ilse's experiments upon the colour preferences of butterflies.

Such investigations as have been suggested may not result in great discoveries—great discoveries lie in the lap of the gods—but for the observer they mean a training in accuracy, persistent or continuous observation, careful recording, and in the end that rigid consideration which leads from facts to general truths. To the societies, the natural history outlook will bring new vigour, and with it that satisfaction and honest pride which go with the enlarging, even in modest degree, of the bounds of knowledge.

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Britain. He points out that the basic unit in British local administration is the parish, the zone of influence of a single place of worship in the Middle Ages. Rural districts, urban districts and boroughs have been built up by the aggregation of parishes, and national parliamentary representation is still organized on that fundamental unit. As a consequence, in spite of many reforms, there are still more than two thousand separate authorities responsible for local community organization. Early legislation favoured supply by a local council. This favoured the setting up of a large number of small generating stations. The work of Ferranti showed the possibilities of alternating current transmission; but the small areas resulting from the early legislation, the wide distribution of coal and its abundant supply did not give the incentive to A.C. supply that there was in other countries. In 1925, a Government committee was set up under the chairmanship of Lord Weir. The committee came to the conclusion that there was a wide difference between generation and distribution and that retail distribution was a local matter which might suitably be decentralized. The findings of this committee were the basis of the Electricity Act of 1926. A Central Electricity Board was formed to construct and operate a large number of high-tension transmission lines called a Grid. The board divided the network into nine schemes covering the whole of Great Britain except northern Scotland. Not only did the construction of the Grid have a beneficial effect upon national employment at a time of acute depression, but also the experience in high-voltage construction which it entailed has placed British manufacturers once more in the forefront of technical progress.

University's Care of Body and Mind

RENSSELAER POLYTECHNIC INSTITUTE, founded in 1824 at Troy, New York, claims to be the oldest institution of higher learning in any English-speaking country that has devoted itself continuously to instruction and research in science and engineering. In a recent bulletin, it directs attention to the very thorough provision it has made not merely for the technical efficiency of its graduates but also for ensuring the physical fitness and bodily vigour of its undergraduates and for developing in them a broad and balanced mental outlook. Applicants for admission are examined physically; and if corrective exercises seem advisable they are prescribed by the Department of Physical Education. Every undergraduate is required to take during the first year a comprehensive course in physical education, including personal hygiene, recreational games, gymnastics, swimming and athletics. Medical advice and hospital care in case of need have been made available for all students. A member of the staff of a neighbouring hospital is in attendance daily for an hour and a half in the gymnasium for consultation. In the first year every undergraduate has to qualify in English, drawing, history, graphics, mathematics, physics and chemistry, and has to prepare a thesis during the summer vacation. The English course covers the material and methods of composition as illustrated by the successive steps in the preparation of a comprehensive article on a subject of immediate interest, the preparation and delivery of incidental speeches and a survey of contemporary ideas and current usages. Except in the case of students of architecture, all undergraduates also take a brief course introductory to professional study, designed to acquaint them with the materials and methods of study in different fields, to introduce them to the members of the faculty whom they will eventually meet in their work, and to indicate the nature of the openings which will be available to them upon graduation.

Natural History and Science in South Australia

THE presidential address before the Royal Society of South Australia, delivered by Dr. C. T. Madigan last year, is devoted to the history of the hundred years of science in South Australia as appropriate to this centenary year (*Trans. Proc. Roy. Soc. S. Australia*, 60, Dec. 1936). He points out that the Royal Society is really older than the State itself, for though it has an unbroken existence only since 1853, its origin can be traced back to the South Australian Literary and Scientific Association initiated among the founders of the Colony in London in 1834. The active functioning of the Royal Society dates from the inspiring presidency of Prof. Ralph Tate; in the twenty-five years of his association with the Society between 1876 and 1901, it became the established medium for publication of original scientific contributions. The nature of this published work is summarized by Prof. Harvey Johnston for general zoology, by Sir Douglas Mawson on geology, by Prof. J. G. Wood and Mr. J. M. Black on botany, by Dr. James Davidson on entomology, and Dr. T. D. Campbell on anthropology. Naturally these descriptive and natural history subjects, so important in a young colony, bulk most largely in this first century, and Prof. R. W. Chapman's report, whilst reminding us that many of Sir William Bragg's first publications in physics appeared in the *Transactions* of the Society, makes it most abundantly clear why this state of affairs prevailed. Before the Society or its predecessor, the Adelaide Philosophical Society, could spend its energies upon the publication of natural history, it had to pass through a phase in which it was the public forum for the advocacy of any and every cause associated with general education. In those days, even so late as 1868, a speaker urging the establishment of free schools, could quote a South Australian parent in this strain, "I have ten children who can't read or write. I can't read or write myself, why should they?"

Zoology of Iceland

THE study of the zoology of Iceland has lagged behind the investigation of its geology and geography, but a new work in five volumes on the "Zoology of Iceland" should form a worthy contribution to the knowledge of a fauna of unusual interest from several points of view (Copenhagen and Reykjavik: Levin and Nunksgaard). The work will be carried out by specialists, and each part will appear as it is

completed, so that publication will be discontinuous and will probably cover a period of about ten years. To subscribers parts will be sold at Kr. 1·00 per sheet, and the whole work is estimated to contain about 100–150 sheets. The two parts first to be published have been received—R. Spärck on "The Benthonic Animal Communities of the Coastal Waters", and E. Wesenberg-Lund on "Gephyrea". Both authors find that the fauna with which they deal consists mainly of an arctic and an arctic-boreal admixture, in which the latter predominates, and with which rare forms, such as the gephyrean *Sipunculus norvegicus*, represent a southern fauna which may have survived from a warmer period. In summing up the conclusions of his investigation, Spärck points out that the absence of a boreal shallow-water fauna seems to indicate that in post-glacial time no land connexion can have existed between Iceland, the Faroes and the continent of Europe. But the fauna itself is by no means a sparse one, since in quantity it compares favourably with the fauna of the North Sea, which is generally considered to be very productive and is richer than the corresponding faunas of East Greenland and northern Russia. This relative wealth of bottom fauna may be a dominant factor in determining the presence of a fish population, which in turn has determined the importance of the fisheries in Iceland waters.

Plants and the Dwelling-House

MOST people readily admit the value of cut blooms and growing plants for decoration of the home, but not all plants can make good growth in the somewhat trying conditions of the average dwelling-house. A recent publication of the Field Museum of Natural History, Chicago, is entitled "House Plants" (No. 20, 1937, 35 cents). It has been written by Mr. R. van Tress, and maintains the well-known practical outlook of this Museum's publications. Such well-tried subjects as the *Aspidistra* (here called, most appropriately, the 'cast iron plant'), the small conifer *Araucaria excelsa*, various geraniums, and the india-rubber plant (*Ficus elastica*) are known to all. The leaflet also shows that hybrid species of *Hippeastrum*, *Hydrangea*, *Poinsettia*, *Begonia*, *Azalea*, *Primula sinensis*, heliotrope, the African violet (*Saintpaulia ionantha*), the shrimp plant (*Beloperone guttata*) and many others, including the common English ivy, are suitable for domestic conditions. They give greater and more varied beauty than the better-known species. Many illustrations enrich the leaflet, and there would seem to be no reason why the plants mentioned therein should not succeed in Great Britain as well as in the United States.

Supraconductivity

THE issue of the *Journal of the Washington Academy of Sciences* of June 15 contains the address of the retiring president of the Academy, Dr. F. B. Silsbee, of the Bureau of Standards, delivered in January. It extends to twenty pages, and deals with the additions which have been made during the last two or three years to our knowledge of the electrical properties of metals at very low temperatures. References are given to previous summaries up to 1935 and to nearly thirty memoirs on the subject which have been published since, most of them in 1936. The original description of a supraconductor as one in which the resistivity is zero is beginning to be replaced by the newer one that the magnetic induction is zero and that any current which flows in it is confined to an excessively thin layer at its surface. The abruptness of the change of conductivity as the temperature is lowered has been investigated, and in the case of tantalum has been expressed by means of the error function. The paradox of how a magnetic field which cannot penetrate a supraconductor can still affect its conductivity is still unsolved, and the reasons for the decrease of heat conductivity and increase of specific heat in the supraconducting state have still to be determined.

Philadelphia Academy of Natural Sciences

THIS year the Academy celebrates its one hundred and twenty-fifth anniversary, and the opportunity has been taken of relating to friends and members in a special report the work accomplished during the past year. The title chosen for the report is "Discovery" (which unfortunately duplicates the name of a well-known British scientific periodical). The year was marked by the announcement of an ambitious programme which included the strengthening of the scientific work of the Academy, the inauguration of an Education Department which would correlate the work of the Academy with the public and private school system in Philadelphia, the erection of modern educational exhibits, and the re-establishment of the Department of Geology and Palæontology. For the support of the educational programme over a five-year demonstration period a sum of 374,915 dollars was required, and the response to the end of 1936 reached the fine total of 241,135 dollars. Already important steps have been taken towards the accomplishment of the programme, and we note with satisfaction that the first step was to restore the reductions which had been made during the period of stress in the salaries of the staff. We join with the Academy in lamenting the death on January 22 of its president, Mr. Effingham B. Morris, who since his election to the presidency in 1928 has been the leader and stimulus in all phases of the Academy's work for science and for the community.

Peace Movements

THE "Peace Year Book, 1937" (London: National Peace Council. 2*s*.) contains a good deal of useful information on international affairs and should prove a reliable book of reference on the peace movement throughout the world. It includes directories of peace organizations in Great Britain, of national organizations, Anglo-foreign societies and local peace organizations as well as peace and kindred organizations abroad. The appendixes include the text of the Covenant of the League of Nations, a bibliography of books and pamphlets, notes on the reform of the League, the Mandates System, an analysis of the

armaments situation and an extensive summary by Dr. Hilda Clarke of the report of the Royal Commission on the Private Manufacture of and Trading in Arms. The first part of the book contains articles on international affairs, the situation in Spain receiving special attention, and the work of the League of Nations in 1936 is reviewed by Maurice Fanshawe. Of special interest to scientific workers is an able article in the second part of the book by J. D. Bernal on "Science and Peace", in which some account is given of the work of the Science Commission of the World Peace Congress. The general resolution on the attitude of scientific workers to war is given in full, together with the report of the Science Sub-Commission, and Mr. Bernal indicates some of the responsibilities of men of science in this matter.

Training in Domestic Science

In the *Electrical Age* of July 1, a quarterly journal published by the Electrical Association for Women, an interesting description is given by Anne R. Macarthur of the Glasgow and West of Scotland College of Domestic Science, one of the most important women's training colleges in Great Britain. There are now three hundred students taking the three years (sometimes four years) 'teaching diploma' courses. In addition to the usual household subjects are cooking for sailors and yachtsmen, hygiene, etc. The college was built in 1911, the rooms being light, airy and spacious, but it was no sooner finished than it was taken over as a War hospital. During the past session, 1,697 students have attended the college for diploma courses as teachers of domestic science and as dieticians. They have the advantage of working with every type of equipment which they are likely to meet on completion of their course. Electricity figures prominently in the 24 kitchens, 5 laundries, 14 sewing rooms and in the residences and model flats of the College. The College residences are lofty houses overlooking Kelvingrove Park and all have bedrooms for one, two or more occupants, pleasantly furnished sitting-rooms and modern bathrooms. A common room with a parquet floor and softly coloured furnishings extends the full width of the building. On the roof, a bijou isolation hospital, with a small electrically equipped kitchenette offers comfort and most hygienic conditions to invalids.

Natural History in the Schools

The annual reports of two school societies, the Marlborough College Natural History Society and the Rugby School Natural History Society, suggest that the schools are taking their due place in the training of the naturalists of the future. Both Societies have had a busy year. Marlborough has dropped from the report the local hand-lists, which must have given to young collectors many a useful pointer towards identification of species, and it has discovered that the members prefer an informal ramble to the massed expedition of a formal field day, which is all to the good from the point of view of training observation. Rugby includes long lists of the seaweeds and marine fauna of Port Erin, which do not seem to be particularly appropriate, although the introduction on the zoning of marine forms illustrates a useful type of observation. Both reports contain records of the local fauna made by members, and both Societies have a useful credit balance on the year's accounts, notwithstanding that Rugby spent more than £400, mostly in erecting a new vivarium and in altering and redecorating the rooms of various sections.

Agricultural Research in Great Britain

The annual reports on the work carried out at the various agricultural research institutes in the United Kingdom during 1934–35 have now been published (H.M. Stationery Office. 5*s*. net). The volume also includes reports of certain other agricultural investigations carried out under the auspices of the Agricultural Research Council, and an account of the research activities of the agricultural advisory officers. In view of the scope of the work described, it has of necessity been published in summarized form, but those desirous of further information will find references to the original papers in the appropriate section, and the names and addresses of the directors of the institutes to whom inquiries may be sent.

Grants for Metallurgical Research

The Iron and Steel Institute offers annually a limited number of grants from the research fund founded by the late Mr. Andrew Carnegie in aid of metallurgical research work. The object of the scheme is to enable students who have passed through a college curriculum, or have been trained in industrial establishments, to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. The value of the grant will depend on the nature of the proposed research work, but the maximum amount granted in any one year will, as a rule, not exceed £100. Applications for grants must be made before September 30. Further information can be obtained from the Secretary, Iron and Steel Institute, 28 Victoria Street, London, S.W.1.

Third Prehistoric Congress of the Far East

The third Prehistoric Congress of the Far East will take place at Singapore on January 24–29, 1938. Membership of the Congress is confined to delegates nominated by their respective Governments or by scientific societies and institutions. Other anthropologists and prehistorians, however, will be allowed to attend the sessions of the Congress as visitors. They will enjoy all the privileges of members of the Congress, with the exception of the right to vote. The official languages which will be recognized are English, French and German. There is no subscription. Applications for invitation should be addressed to the Director, Raffles Museum, Singapore, Straits Settlements.

Metal-Ammonia Ions

In connexion with the letters from F. J. Garrick and from Dr. J. S. Anderson, N. L. Spoor and Prof. H. V. A. Briscoe published in NATURE of March 20, 1937 (p. 507), Prof. A. A. Grünberg, Kovensky pereulok 22, log. 12, Leningrad, has been good enough to give references to several papers by himself and his collaborators which are for the most part inaccessible to English readers. In these, during the last seven years, it has been shown experimentally that the ammines of platinum and rhodium may undergo acid-dissociation by a mechanism similar to that inferred from the exchange experiments on cobalt ammines. Prof. Briscoe and his collaborators state that they are glad to learn that their entirely independent experiments afford, both qualitatively and quantitatively, so satisfactory a confirmation of the findings and predictions Prof. Grünberg has already published. Of the more recent references he gives, one (A. A. Grünberg and D. T. Rjabtschikoff, *Acta Physico-Chimica*, 3, No. 5, 555; 1935), which is in German, and may be seen in a few British libraries, should certainly be consulted by chemists interested in this subject.

Medical Research in India

THE first annual report, for 1935–36, of the Indian Institute for Medical Research has been issued by the Governing Body. The Institute in Calcutta commenced work on January 1, 1935, with a 'diagnostic' section, for helping medical practitioners, and four research departments, and a brief survey of research work carried out is given. This includes the preparation of a potent anti-cholera serum, trials of which are now being carried out, a vaccine for the treatment of oriental sore (leishmaniasis), nutritional researches, with the discovery that some common Indian fruits contain a high content of vitamin C, and the mechanism of antigen-antibody combination.

Announcements

THE second International Congress of Cosmobiology will be held at La Malou on September 19–21. Further information can be obtained from Dr. M. Faure, La Malou, Hérault, France.

THE second International Scientific Congress of Alimentation will be held in Paris in the second fortnight of October and will consist of the following six sections; physiology of feeding, rules for normal feeding, feeding in the colonies, the teaching and social importance of food hygiene, and the protection and supervision of articles of food. Further information can be obtained from M. Alquier, 16 rue de l'Estrapade, Paris 5e.

THE one hundred and fiftieth anniversary of the birth of the celebrated Czech physiologist and histologist Johannes Evangelista von Purkinje will be celebrated by a series of ceremonies and addresses at Prague, Brno and Bratislava on September 24–28. Further information can be obtained from the secretary, Dr. Jarmila Psotnickovà, 32 Katerinka, Praha II.

THE Serbian Royal Academy of Sciences, which is composed of four academies—those of social science, natural science, philosophical science and fine arts—recently celebrated the fiftieth anniversary of its foundation in the presence of the Regent, Prince Paul of Yugoslavia, Dr. Radenko Stankovitch, formerly professor of the Faculty of Medicine at Belgrade, the Patriarch of the Orthodox Church, and a number of other well-known scientific workers and high officials of the Balkan countries.

THE library of the Radcliffe Observatory, Oxford, is about to be transferred to its new quarters in South Africa, and publications intended for it should now be addressed to "The Radcliffe Observatory, Pretoria, South Africa", instead of to Oxford.

A LECTURE COURSE on industrial law has been arranged by the Industrial Welfare Society at its headquarters, 14 Hobart Place, S.W.1, beginning on October 4 at 6.30 p.m., for ten weeks, and will be conducted by Mr. H. Samuel, barrister-at-law. Further information can be obtained from the secretary of the Society.

AN exhibition of Egyptian antiquities newly found at Armant by the Sir Robert Mond Expedition has recently been arranged at the Archæological Institute, St. John's Lodge, Regent's Park, London, N.W.1, by the Egypt Exploration Society. The exhibition will remain open until September 25. Admission and catalogue are free.

WE have received a communication from the Secretary of St. Joseph's House, Diocesan Home for Boys (a home for orphan and destitute boys), 126 Baker Avenue, Salisbury, Southern Rhodesia, stating that it is proposed to encourage the boys in the study of science, including microscopy. The Secretary would be grateful for gifts of small microscopes which any reader may be prepared to present to the Home.

THE Sir William White Post Graduate scholarship in naval architecture (1937) of the Institution of Naval Architects has been awarded to Mr. Allan M. Baxter, of the Royal Technical College, Glasgow.

THE following scholarships for 1937 have been awarded by the Institution of Electrical Engineers: Duddell Scholarship to R. S. Peacock, King's School, Ely; Swan Memorial Scholarship to Dr. B. C. Robinson, Armstrong College, Newcastle-on-Tyne; William Beedie Esson Scholarship to R. P. Kinsey, of Evershed and Vignoles Ltd.; Silvanus Thompson Scholarship to J. R. Catlin, of Igranic Co. Ltd.; David Hughes Scholarship to L. Lieberman, Queen Mary College, London; Salomons Scholarship to S. G. Bittles, College of Technology, Belfast; War Thanksgiving Education and Research Fund (No. 1), Grant of £50 to J. E. Parton, University of Birmingham; Paul Scholarship to T. H. Fulford, Acton Technical College, London.

ERRATUM.—Dr. Gwyn Williams informs us that the MS. of his letter "Kinetics of Catalysed Polymerization of Styrene" (NATURE, Aug. 28, p. 363) contained an error. The polymers produced have molecular weights of the order 3,000, not 5,000 as printed (p. 364, col. 1, line 10).

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. 428.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Light thought to have been seen in the Neighbourhood of Alternate Current Magnets

THE late Prof. S. P. Thompson showed that visual effects (excitation of the optic nerve) were produced when the head was placed in an alternating magnetic field.[1] He said, further :

"Nearly four years ago Prof. Birkeland of Christiania told me that his workmen at the nitrate factory at Notodden declared that they could see lights over the choking coils used to limit the currents supplied to the electric furnaces. This may have been in reality a subjective phenomenon similar to that now recorded."

No doubt the view expressed by Prof. Thompson is the most probable. It seemed worth while, however, as a 'fool experiment', to see whether objective lights could be detected by prolonged photographic exposure.

Dr. W. H. Hatfield, to whom I casually mentioned the idea, was so kind as to interest himself in it, and he had a suitable alternate current magnet constructed at the Atlas and Norfolk Works, Sheffield. The iron was, of course, laminated, the gap between the poles being about 0·7 mm. wide and about 8 mm. deep. The mean flux density through the cycle was 4800 lines per sq. cm.

The top of the magnet was flat, so that a photographic plate could be brought right up to the gap, the lines of force being parallel to it. An Ilford hypersensitive panchromatic plate was used, with a thin sheet of 'Cellophane' between it and the magnet.

If the effect existed, there should have been a dark line on the plate, corresponding to the gap. Exposures up to thirty days were given, but no positive result was obtained. Some test experiments indicated that a luminosity fairly distributed through the visual spectrum and just bright enough to be seen by a well rested eye should have impressed the plate easily in twelve hours. The actual exposure was some sixty times greater. It appears most improbable, therefore, that any objective lights can exist. Perhaps most readers of NATURE would have been content to assume that in the first instance.

RAYLEIGH.

Terling Place, Chelmsford.
August 17.

[1] *Proc. Roy. Soc.*, B., 82, 396 (1910).

Cosmic Rays and Magnetic Storms

S. E. FORBUSH[1] has noted a systematic decrease of cosmic ray ionization at Cheltenham, U.S.A., and Huancayo, Peru, simultaneous with a decrease of the earth's horizontal magnetic force (H.F.), during magnetic storms of April 1937. V. F. Hess and A. Demmelmair[2] have confirmed the existence and world-wide character of the cosmic ray decrease by observations on the Hafelekar near Innsbruck. They agree with Forbush in concluding that the study of these cosmic ray changes during magnetic storms will give valuable information on the spectrum of the cosmic radiation.

It promises also to settle an important unsolved question which bears closely on the mode of origin of magnetic storms themselves. The most intense disturbance of the earth's surface field during a magnetic storm usually occurs in polar regions; but this is not the part of the disturbance with which the greatest change in the energy of the magnetic field round the earth is associated. The energy change depends mainly on the general decrease of H.F. that occurs in all latitudes during and after the main phase of a magnetic storm[3]. The polar magnetic disturbance appears to be due to electric currents in the earth's atmosphere, but it is not known where the general decrease of H.F. is produced, except that the main cause is above the earth[4]. It may be in the highest layers of the ionosphere or right outside the atmosphere.

Ferraro and I have tentatively suggested[5] that it may be due to a ring current encircling the earth at a radial distance of a few earth-radii, a, and composed of positive and negative charges in oppositely directed orbital motions. Størmer[6] had earlier suggested a ring current of much larger radius, composed of charges of one sign only. I have criticized this hypothesis on various grounds[3,4], one being that it would imply an appreciable modification of the earth's field, during a storm, throughout an immense volume of surrounding space, in a manner likely to alter considerably the normal paths of cosmic rays. The present observations give a quantitative relation between the change in cosmic ray intensities and the magnitude δH of the decrease in H.F. at the equator during a storm; they should, with the aid of such calculations of cosmic ray paths as have been made by Størmer and by Lemaître and Vallarta, lead to an estimate of the distance of the currents which reduce the H.F.

Below these currents the H.F. is reduced, above them it is increased, and there the main component of the earth's field corresponds to a doublet of magnetic moment $M + \delta M$ exceeding the earth's normal moment M. It is presumably this increase δM, in this outer space, which accounts for the decrease of cosmic ray intensities.

Theoretical discussion of the cosmic ray change might conveniently be based on the following simple model of the earth's field during a magnetic storm. It is not intended to represent all the important actual features of the field, even if the currents concerned are located in the high ionosphere, and still less if they are ring-currents outside; but it should give the order of magnitude of the radius a' at which the currents are located.

Take one third of the equatorial decrease of H.F. to be due to induced internal currents (having an equivalent magnetic moment $-\frac{1}{2}a^3\delta H$), and two thirds to be due to external currents. Take these to be distributed over a concentric spherical shell of radius a', the current intensity being proportional to the cosine of the latitude; the field within the shell will be uniform, $-\frac{2}{3}\delta H$, and outside it will be that of the doublet of moment $+\frac{2}{3}a'^3\delta H$. Thus, for $r > a'$, the equivalent doublet of the total field will be $M + \delta M$, where $\delta M = \frac{1}{3}(2a'^3 - a^3)\delta H$. In this region the existing theory is applicable, with merely this change in M. For $a < r < a'$, the field will be that of a doublet $M - \frac{1}{2}a^3\delta H$ and a uniform field $-\frac{2}{3}\delta H$; in this region special calculations are needed. The important point is to determine whether a'/a is but little greater than unity, which would indicate that the currents are in the high ionosphere, or of magnitude 2, 3 or more, which would favour the ring-current hypothesis of the main phase of a magnetic storm.

S. CHAPMAN.

Imperial College of Science,
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London, S.W.7.
Aug. 23.

[1] *Phys. Rev.*, **51**, 1108 (1937).
[2] NATURE, **140**, 316 (1937).
[3] *Terr. Mag.*, **37**, 269 (1932).
[4] *Terr. Mag.*, **40**, 349 (1935).
[5] *Terr. Mag.*, **36**, 77–97, 171–186 (1931); **37**, 147–156, 421–429 (1932); **38**, 79–96 (1933).
[6] *Arch. Sci. Phys.*, **32**, 277 (1911).

The Cluster Theory of Imperfect Gases

DEVIATIONS from ideality of real gases are generally attributed to the effects of the volume of the molecules and to the attractive forces between them. The volume effect has been described fairly simply and accurately, but explanations put forward as to the way in which the attractive forces act are open to criticism. One of the older common explanations[1] is that the unbalanced attraction inwards on the molecules near the boundary wall results in their being slowed down before they hit the wall, thus giving a lower contribution to the pressure than they would in the absence of attractive forces. *As stated*, this appears to be a violation of the Principle of Equipartition of Energy. Another way of expressing what is probably the same thing, is often preferred[2]. In this, the deficiency in pressure is attributed to a lower concentration in the boundary layer arising out of a relatively higher potential energy in this layer, due to the attraction inwards. These explanations ignore the fact that adsorption measurements show that all known walls exert a strong attractive force on all gaseous molecules and that the concentration in the boundary layer is invariably higher than that in the body of the gas.

Extensive mathematical treatments of the properties of imperfect gases have been made by Keesom[3], Core[4], and others[5]. These are based on the well-known statistical law that the probability of finding molecules in an element of volume dv is proportional to $e^{-X/kT}dv$, where X is the potential energy of the molecule. The treatment leads to the expected result that *molecules are more likely to be found in an element of volume within the range of molecular attraction than in a volume outside this range.* It also gives values for the 'second virial coefficient' of gases, a coefficient to which $\left(b - \frac{a}{RT}\right)$ of van der Waals' equation is in approximation.

Attempts at obtaining a kinetic picture of the above result lead to an interesting conclusion. Consider any molecule in a gas moving with a definite velocity. As it enters a region of lower potential energy such as occurs in the neighbourhood of another molecule its kinetic energy increases. During the whole of the period while it is in this region, except for the small fraction of time of actual collision, the molecule moves *faster* than before the collision. If this were the complete picture, molecules would spend *less* time in an element of volume within the range of molecular attraction. It might be argued that a consideration of all types of collisions would give a mean different from this. Calculations of a number of typical cases have, however, failed to reveal any exceptions. As an extreme example, overtaking and overtaken molecules spend a longer time than usual inside the range, but they would spend a still longer time inside the same volume if there were no attractive forces.

It is obvious from the above argument that molecules *normally avoid* elements of volume in the neighbourhood of attracting molecules, a fact that should give rise to a correction term of the same sign as the 'b' term of van der Waals' equation. The observed sign is, of course, the opposite. This can only be explained by assuming that a molecule, while in a range of low potential energy, sometimes loses part of its kinetic energy by collision with a third body, forming a stable 'cluster' with the other molecule. These clusters have a comparatively long life and more than compensate for the effect described above, giving a net result of the right sign. For complex molecules third body collisions are unnecessary, as the energy may be temporarily transferred to another degree of freedom of the system.

This phenomenon of stabilization is a general one entering into all kinds of equilibria involving fields of force. In the simple case of any molecule moving downwards in an isothermal box in a gravitational field, its velocity will increase and, in the absence of collisions, it will normally spend *less* time in the region of low potential energy. The Boltzmann distribution arises from the fact that a few molecules lose so much energy on collision with the walls that they are unable to rise to the top against the field, and spend therefore a much longer time at the bottom.

The existence of clusters has been postulated by many writers to explain their observations on various properties of real gases. Van der Waals[6] himself believed them to exist near the critical point; he used the term *Scheinassoziation*. In the derivation of van der Waals' equation of state by Herzfeld and Smallwood[5], the formation of clusters is realized. Volmer[7] discusses the likelihood of molecular aggregates acting as condensation nuclei in pure supersaturated vapours. The possibilities in the Cluster Theory to explain the behaviour of gases have not, however, been generally realized and the theory is not to be found in elementary textbooks.

Tri- and tetra-molecular clusters are formed in a similar manner, particularly at higher pressures. At normal pressures, di-molecular clusters predominate, a fact which, with the Mass Law, leads at once to an equation of state of the type of van der Waals.

It is proposed to discuss elsewhere the ways in which the Cluster Theory permits simple treatments of other physical properties of gases, such as specific heat, viscosity, light scattering, the Joule-Thomson effect, and the pressure-broadening of spectral lines.

C. F. GOODEVE.

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June 15.

[1] See, for example, O. Maass "Physical Chemistry" by Taylor, vol. 1, p. 98 (1924); W. C. McC. Lewis "Kinetic Theory", p. 72 (1923); and Washburn "Principles of Physical Chemistry", p. 38 (1921).

[2] Fowler, "Statistical Mechanics" p. 291 (1936).

[3] Keesom, W. H., *Phys. Z.*, **22**, 129 and 643 (1921); **23**, 225 (1922).

[4] Core, A. F., *Phil. Mag.*, **46**, 256 (1923).

[5] A brief treatment is given by Herzfeld and Smallwood, "Physical Chemistry" by H. S. Taylor, p. 226 (1931).

[6] Van der Waals, Nobelpreisrede (Leipzig, 1911).

[7] Volmer, *Z. Elektrochem.*, **35**, 555 (1929).

A Method of obtaining Polarized Neutron Beams

RECENT progress in cooling methods have made it possible to obtain temperatures where kT becomes comparable with the energy separation, due to space quantization of nuclear spins in high magnetic fields.[1] The nuclei will, under such conditions, occupy the lower levels of space quantization more abundantly than the higher ones, provided that temperature equilibrium between the lattice of the cooled substance and its nuclei is obtainable.[2] This effect is equivalent to a polarization of the nuclei, and might be useful for obtaining highly polarized neutron beams without great loss of intensity.

Should the nuclei in question have a resonance level for absorption of slow neutrons (thus absorption by an S-level) it would be expected that the capture cross-section would be very dependent on the relative orientation of the neutron spin and the spin of the capturing nucleus. In the special case of an unexcited nucleus having the spin 1/2 and the compound nucleus—formed by slow neutron capture—the spin 0, the cross-section should be zero for neutrons the spin of which is parallel to the nuclear spin, whilst it should be normal for neutrons of opposite spin orientation. A substance the nuclei of which are polarized will thus polarize a beam of slow neutrons by selective absorption of one component of spin orientation. The degree of polarization will only depend on the ratio of occupation of the two levels of space quantization.

In the rare case of a group of thermal neutrons principally due to one nuclear resonance level, this method will furnish polarized beams of thermal neutrons, as the method proposed by F. Bloch.[3] In most cases, however, only neutrons belonging to one particular resonance level—thus neutrons having energies of several volts—will be polarized. Precession experiments with such neutrons will permit of measurements of their velocity.

Added in proof: Halpern and Johnson[4] point out that some paramagnetic salts could give higher magnetic scattering cross-sections for slow neutrons than iron, the atomic factor being bigger. At ordinary temperatures scattering of slow neutrons by paramagnetic salts will not furnish polarized neutron beams. It might, however, be useful to employ for the polarization method proposed by F. Bloch[3] paramagnetic salts magnetized at very low temperatures instead of magnetized iron.

HANS V. HALBAN, JUN.

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August 14.

[1] Kürti, N. and Simon, F., *Proc. Roy. Soc.*, A, **149**. 152 (1935). de Haas, W. J. and Wiersma, E. C., Rapport 7me Congr. Int. Froid, 267 (1936).

[2] Heitler, W. and Teller, E., *Proc. Roy. Soc.*, A, **155**. 629 (1936): Gorter, C. J., *Physica*, **3**, 995 (1936).

[3] Bloch, F., *Phys. Rev.*, **50**. 259 (1936).

[4] Halpern, O., and Johnson, M. H., jun., *Phys. Rev.*, **52**. 52 (1937).

Circular Ultra-sonic Grating in Liquids

A. Žáček and V. Petržílka have recorded observations of radial and torsional vibrations of annular quartz plates cut perpendicular to the optical axis and have found that, with radial oscillations, standing ultra-sonic waves, which can be rendered visible by means of precipitated lycopodium, are formed in the hole in the middle of the crystal plate.

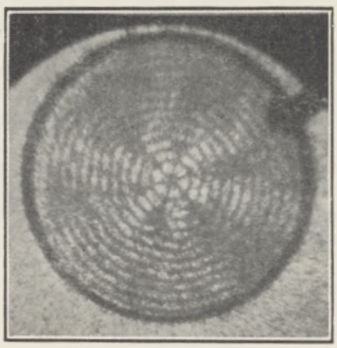

FIG. 1.

A closer investigation of the acoustic field showed that one was dealing with a complicated phenomenon, and that the ultra-sonic waves might be caused not only by radial vibrations but also by other types of vibrations, thus forming interesting figures of lycopodium. This fact was the reason for producing ultra-sonic waves in both gases and liquids, and observing them closely. These experiments have shown that the ultra-sonic waves formed in xylol, or better in a mixture of xylol and carbon tetrachloride, can be observed not only in the hole but also around the crystal plate. In the case of radial vibrations, only concentric circles are produced. If we make use of other types of vibrations, not only concentric circles, but also diametrical lines may appear (Fig. 1). This phenomenon is in all probability connected with the electrical axis of the quartz crystal. The circular grating formed in the liquids by the standing waves will be further utilized in diffraction experiments.

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July 28.

Vitamin E Deficiency in the Suckling Rat

IT has been reported previously[1,2] that partial deficiency of vitamin E in the doe rat leads to the production of abnormal young. This abnormality is associated with both anterior pituitary deficiency and thyroid deficiency. It is most marked when the litter is about eighteen days old and usually results in death three or four days later.

Since at birth the young, though small, appear otherwise normal, it seemed possible that the abnormality develops after birth and might be prevented if the young were fed by a normal doe. An E-deficient rat had a litter of three—two males and one female. Five days after birth, the two males were exchanged for four males from the normal breeding stock which were born on the same day. The stock mother then had her own females and the four normal males. All the young suckled by the E-deficient doe were abnormal at 16 days, and all were dead two days later. The thyroid glands were examined histologically and all showed the hypoplasia typical of this condition. All the young suckled by the normal rat grew well and showed no sign of abnormality. The experiment was repeated, with the same result, when the females from the two litters were exchanged on the fifth day, and again when the young were transferred on the day of birth.

This experiment shows that the young of vitamin E-deficient rats are born normal, but that thyroid and anterior pituitary deficiency develop as a result of the lack of some essential constituent of the mother's milk. This missing factor is almost undoubtedly vitamin E since lack of this vitamin results in similar changes in these glands in the adult rat, although the accompanying symptoms of stunted growth, uncalcified skull, clenched feet and weakness are not observed because the animal has already attained maturity.

M. M. O. BARRIE.

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Aug. 10.

[1] Barrie, M. M. O., NATURE, 139, 286 (1937).
[2] Barrie, M. M. O., *Lancet*, ii, 251 (1937).

Vitamin P

WE have reported previously that certain flavanones (vitamin P) greatly influenced symptoms of experimental scurvy. This latter condition was interpreted as a mixed C and P avitaminosis. At our request, our experiments have been repeated by several laboratories. The results were partly corroborative and partly negative. The reason of this discrepancy is now cleared up. Vitamin P requires for its activity the presence of traces of ascorbic acid. A scurvy diet frequently contains such traces which in themselves have no influence on the development of scurvy, but enable vitamin P to act. In the entire absence of ascorbic acid, vitamin P is inactive. Quantitative data will be published elsewhere. Previous conclusions are upheld. The object of this note is to prevent superfluous discussion.

A. BENTSÁTH.
A. SZENT-GYÖRGYI.

Szeged.
August 12.

Choline Esterase Activity of Superior Cervical Ganglia

BY a direct chemical micro method the maximum choline esterase activity of the superior cervical ganglion of the cat has been measured and found to be, on the average, equivalent to the splitting of $0{\cdot}10\,\gamma$ of acetylcholine chloride per sec. per mgm. of fresh tissue. The full experimental details will be given in another publication.

This figure may be applied to the data of Brown and Feldberg[1], who found that the greatest output of acetylcholine from the ganglion perfused with eserinized Locke's solution occurs in the first 5 minutes of preganglionic stimulation at 17 per sec. In this time $0{\cdot}1\,\gamma$ was liberated from a ganglion weighing 12·9 mgm. Hence the time required for the splitting of the acetylcholine liberated by one nerve impulse would be

$$\frac{0{\cdot}1\,\gamma}{12{\cdot}9\ \text{mgm.} \times (0{\cdot}10 \times 10^{-3}\ \gamma/\text{mgm.}\ \sigma) \times (300 \times 17)\ \text{stimulations}} = 0{\cdot}015\ \frac{\sigma}{\text{stimulation}};$$

provided that the enzyme and substrate are localized sufficiently so as to obtain a complete combination of the two, that is, theoretical maximum velocity of hydrolysis. Actually, the velocity falls when the concentration becomes less than a certain value; hence $0{\cdot}015\,\sigma$ represents a limiting least time which might be merely approached in actuality. Compared to the refractory period of the ganglion, which Brown[1] has found to be of the order of $2\,\sigma$, it is apparent that the enzyme need operate only with an average rate of about 0·75 per cent of its theoretical maximum velocity in order to destroy the acetylcholine liberated by a nerve impulse within the refractory period. After the first 5 minutes, the quantity of acetylcholine liberated per impulse falls until finally only about a fifth of the initial amount is set free[1]; under these conditions the enzyme could hydrolyse the acetylcholine within the refractory period at about 0·15 per cent of its maximum velocity.

From the foregoing it would appear that the enzyme present is sufficient to destroy the acetylcholine liberated by a nerve impulse within the refractory period. However, it must be borne in mind that for the conditions of minimum velocity of hydrolysis, as in the case of an even distribution of enzyme and substrate throughout the tissue, the reaction velocity would be very far indeed from the maximum one, because of the low substrate concentration and affinity for the enzyme. In this case the time (t_s) for splitting 99 per cent of the substrate is given by:

$$t_s = \frac{1}{V_{\max.}} \int_{S_1}^{S_2} \frac{K_s + S}{S}\, dS,$$

where $V_{\max.}$ represents maximum velocity of hydrolysis, K_s the Michaelis constant for the affinity between enzyme and substrate, S the substrate concentration at any moment, S_2 the original substrate concentration, and S_1 1 per cent of S_2. It follows that

$$t_s = \frac{1}{V_{\max.}} \left(K_s \ln \frac{S_2}{S_1} + S_2 - S_1\right) = \frac{4{\cdot}6K_s + 0{\cdot}99S_2}{V_{\max.}}$$

Since the value of K_s, which I am now investigating, is unknown for the enzyme from the source in question, it is sufficient for a rough calculation to assume it to be of the same order of magnitude as the K_s already found in the case of human serum[3], namely, 0·001, from which t_s becomes about 8 sec.

In order that this time be reduced to 2 σ, it would be necessary for the enzyme and substrate to be concentrated within a small portion of the total ganglionic volume, such as at the nerve endings. Already evidence for a localization of this type has accumulated[4,5].

The calculation given above is merely an approximation, and serves only to show the enormous gap between the time for splitting under minimum and maximum conditions, and the necessity for localization of enzyme and substrate within the ganglion cell if the theory of chemical mediation is to hold.

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Copenhagen.
Aug. 7.

[1] Brown, G. L., and Feldberg, W., *J. Physiol.*, **88**, 265 (1936).
[2] Brown, G. L., *J. Physiol.*, **81**, 228 (1934).
[3] Glick, D., *Biochem. J.*, **31**, 521 (1937). *Compt. rend. Lab. Carlsberg*, 21, No. 15 (1937).
[4] von Brücke, F. Th., *J. Physiol.*, **89**, 429 (1937).
[5] Dale, H. H., "The Harvey Lectures" (Williams and Wilkins Co., Baltimore, 1936–37).

Choline Esterase in the Central Nervous System

THE theory of transmission of nervous impulses to the voluntary muscles postulates the presence of a high concentration of choline esterase in nerve endings or their neighbourhood[1]. We have previously demonstrated the accumulation of choline esterase at the end plates of muscle[2]. We have now compared the rate of hydrolysis of acetylcholine in the grey and white matter of the spinal cord of the dog and found the concentration 10–20 times higher in the grey matter. 100 mgm. grey matter hydrolyse 7–9 mgm. acetylcholine in one hour, while 100 mgm. white matter split only 0·4–0·9 mgm.

In the central nervous system, as in muscle, choline esterase is found in high concentration in the tissue that contains nerve endings. This suggests that in the grey matter the enzyme may have a similar functional significance as at the end plates of muscle, that is, the rapid removal of acetylcholine, and that this substance may act as transmitter of nervous impulses in the central nervous system.

In the nervous system of crustaceans (lobster) there is also a higher concentration of choline esterase in the ganglion cells than in the nerve fibre.

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July 28.

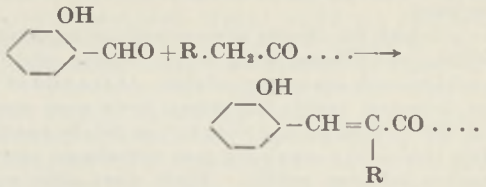
[1] Brown, G. L., Dale, H. H., and Feldberg, W., *J. Physiol.*, **87**, 394 (1936).
[2] Marnay, A., and Nachmansohn, D., *C.R. Soc. Biol.*, **125**, 942 (1937).

Specificity of the Salicylic Aldehyde Reaction of Csonka-Straub

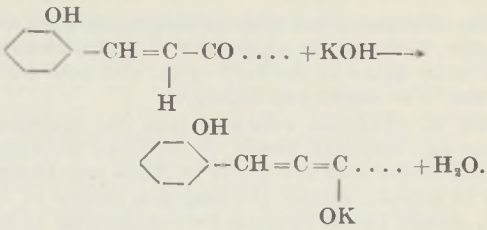
SOME time ago Straub (in Szent-Györgyi's laboratory) described a colorimetric method for the determination of pyruvic acid, similar to the method previously proposed by Csonka for the determination of acetone. In the presence of salycyclic aldehyde and concentrated potassium hydroxide, both substances develop a yellow colour, suitable for colorimetry. Having met with the necessity of determining pyruvic acid in the presence of several other ketoacids, I have made a study of the specificity range of this reaction and obtained the following results.

A positive salicylic aldehyde reaction is obtained with all compounds containing a CH_3CO group linked directly to a hydrogen or carbon atom; for example, acetaldehyde, acetone, ethyl acetoacetate, methylhexylketone, diacetyl, acetophenone, pyruvic acid, levulinic acid. The reaction is negative: (1) with carbonyl compounds that do not contain the above-mentioned group—formaldehyde, propionic aldehyde and higher homologues, ketobutyric acid and all higher ketoacids, fructose, dihydroxyacetone, acetonedicarboxylic acid; (2) with compounds containing a CH_3CO group linked to oxygen or nitrogen, that is O- and N-acetyl compounds, the CO group of which is not a genuine carbonyl group; for example, acetic acid, acetylglycine, acetylcholine, acetylsalicylic acid, triacetin.

The mechanism responsible for this very definite range of reaction specificity is obviously the following. In the first stage of the reaction salicylic aldehyde is condensed with the carbonyl compound to an oxybenzylidene derivative (Perkins' reaction):



If a menthyl group be attached to the carbonyl group of the original compound, that is, in the case R = H, enolization will ensue in a strongly alkaline medium, leading to the formation of an enolate, the intense yellow colour of which is due to the system of cumulated double bonds:



With R other than a hydrogen atom enolization and the formation of the cumulated double bond system is ruled out and no colour will appear, even though benzylidene condensation had taken place. With O- and N-acetyl compounds neither the condensation nor the enolization is obtained under the conditions of the colour test.

The salicylic aldehyde reaction is a sensitive test for the qualitative (and in many instances for the quantitative) determination of any methyl-carbonyl-derivative in the absence of other substances belonging to the same group. The reaction is very important as a valuable means for distinguishing these compounds from the homologous or substituted carbonyl derivatives. The specificity range outlined above should be especially kept in mind when making use of the reaction for quantitative studies on the metabolism of pyruvic acid, which may give rise to substances such as acetaldehyde, acetoin, acetoacetic and acetopyruvic acids and acetone, all falling within the specificity range of the Csonka-Straub reaction.

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A Cage Colony of *Anopheles gambiæ* Giles

MATHIS[1] has reported the successful rearing of *A. gambiæ* under laboratory conditions. He fed the adults on a guinea pig and found that mating occurred in quite small cages. For some years now I have made attempts to establish a laboratory colony of this species without any success. Great difficulty has always been experienced in getting caged adults to feed. The following animals have been tried: shaved guinea pigs, rabbits, goats and human beings. When feeding did take place, no fertilized eggs were recovered. Recently a further attempt has been made, and this has proved successful.

Adult *gambiæ* reared from eggs, obtained from gravid females captured in the field, were placed in an indoor cage lined with asbestos measuring 6 ft. × 5 ft. × 5 ft. The temperature in the cage was kept constant at 25° C. by means of a radiator connected to a thermostat. Large bird-baths and ferns were placed inside, yet the humidity of the air in the cage, as measured by a sling hygrometer, never rose above 40 per cent.

For a month the insects were given the opportunity of feeding on a human being every evening, and they very seldom took advantage of this. At the end of this period, however, nearly full-grown larvæ were seen in one of the bird baths and very robust adults resulted.

After this date a small pig was introduced and the mosquitos fed very readily. Eight days after introduction of the pig, first-stage larvæ were seen in the breeding dishes; these represented the second generation in captivity. Since that date hundreds of larvæ have appeared and third generation adults are now ready to deposit eggs. The colony is regarded as being firmly established.

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[1]Mathis, C., *C. R. Soc. Biol.*, 121, 21–22 (1936).

The Position of Genetics

THE attacks of Lysenko on Vavilov and other Russian geneticists reported in NATURE of August 21 are not wholly dissimilar to Dr. H. Dingle's attack on Prof. E. A. Milne in a recent issue of this journal. Vavilov was accused of being anti-Darwinian, Milne of going back to Aristotle, in neither case perhaps with full justification. If these attacks have led to a curtailment of Vavilov's work, the situation of genetics in the Soviet Union is indeed serious. If not, hard words break no bones, and the outlook for genetics in Moscow is at any rate no worse than in London, where I understand that the only department of genetics in the University is shortly to come to an end.

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Points from Foregoing Letters

LORD RAYLEIGH has made photographic tests to see whether, as had been supposed by certain observers, there were lights in the field of an alternate current magnet. The result was negative.

Prof. S. Chapman indicates that the decrease of cosmic ray intensity noted by Forbush in America (United States and Peru) and by Hess and Demmelmair in Austria, during the magnetic storms of April 1937, should throw light on the mechanism of magnetic storms; in particular, it should show whether the world-wide decrease of horizontal magnetic intensity during a magnetic storm is due to currents in the high ionosphere or to a ring-current right outside the earth's atmosphere.

The 'cluster' theory, which postulates that the molecules of imperfect gases occur in groups (mainly pairs under ordinary conditions), permits, according to C. F. Goodeve, a simple treatment of many properties of imperfect gases.

The possibility of obtaining polarized beams of neutrons by selective absorption on passing through a substance cooled to very low temperatures, the nuclei of which have a resonance level for absorption of slow neutrons, is pointed out by Dr. Hans v. Halban, jun. Paramagnetic salts magnetized at low temperatures might be employed for this purpose.

Standing ultra-sonic waves produced in xylol, or in a mixture of xylol and carbon tetrachloride, by an annular quartz plate can be observed within the ring and also outside the crystal plate. Miss J. Čerovská submits a photograph obtained with radial vibrations, showing that a concentric circular grating has been formed in the liquid; this can be used in diffraction experiments.

Further experiments by Miss M. M. O. Barrie show that the young of vitamin E deficient rats are born normal but that they develop symptoms connected with thyroid and anterior pituitary insufficiency. However, if suckled by a normal rat, the young develop normally, showing that there is a lack of some essential constituent (probably vitamin E) in the mother's milk.

By a micro-chemical method D. Glick has calculated the rate at which choline esterase enzyme, acting on the super cervical ganglion of the cat, can split acetylcholine, a compound liberated during nerve activity. The time required is well within the refractory period of the nerve impulse, provided the known amount of enzyme and substrate are concentrated at the nerve endings. D. Nachmansohn has found an increased concentration of choline esterase at the nerve and plates of muscles and now reports that the grey matter of the spinal cord of the dog contains 10–20 times more choline esterase than the white matter. He suggests that the grey matter may act as transmitter of nervous impulses in the central nervous system.

The salicylic aldehyde reaction which gives a yellow colour with acetone and pyruvic acid (Csonka-Straub) is found by Prof. A. E. Braunstein to be a sensitive reaction for any methyl-carbonyl (CH_3CO) derivative, in the absence of other substances of the same group. The author directs attention to the fact that, in studying the metabolism of pyruvic acid, one should be on the look-out for substances such as acetaldehyde, acetoin, acetoacetic and acetopyruvic acids and acetone, which also give the Csonka-Straub reaction.

Research Items

Clan Reciprocity among the Bororo

IN an account of the social organization of the Bororo Indians of South America, M. Cl. Levi-Strauss refers to certain reciprocal obligations between clans, which he considers worthy of intensive study. He himself was able only to obtain a few discursive notes on the customs this reciprocity entails (*J. Soc. Américanistes de Paris*, N.S., **28**, 2). For example, when the young men are about to be initiated, the chief of the village entrusts their instruction to the phratry opposite to their own. On the death of a member of the tribe, it is customary for a collective hunt to be arranged. The organization of the hunt is entrusted by the nearest relative of the deceased to a member of the opposite phratry. The funeral emblems are handed to him, and he acts as organizer and leader. The preparation for the funerary dances is the duty of special clans; but the clan for whom the dance is prepared must take part as partners. This duality is well expressed in certain dances, in which the dancers stand in two lines and exchange places in the course of the dance. Each line or side belongs exclusively to one phratry. After the dance, the dancers are bathed by the members of the opposite phratry. An even closer tie binding the clans is formed by the interchange of food. At a stated time a member of one of the clans will carry a bowl of food from his own house to the men's house, where it is received with a ritual cry of welcome. Six or eight men of another clan are then fetched to the men's house, and partake of the food with their shell spoons. This exchange of food takes place reciprocally between all the clans, though with the exception of this ceremony and the giving of food to dancers after the dance, all meals are taken in the family dwelling. The privileges of the clans include the exclusive possession of names, songs, dances, and emblems and of certain techniques and materials. These rights are strictly respected.

The Human Sex Chromosomes

FROM a study of spermatogenesis in three individuals, Dr. P. C. Koller (*Proc. Roy. Soc. Edin.*, **57**, 194) has deduced some interesting conclusions. The length of the *X*-chromosome in man is found to be 4–5 μ and that of the *Y* 1·5 μ. These chromosomes frequently lie off the metaphase plate in mitosis, and in anaphase the *Y* frequently lags. In the leptozygotene stages of meiosis the *X* and *Y* are precociously condensed. They are divided into pairing and non-pairing regions. The non-pairing portion of the *X* is about two thirds of its length, while that of the *Y*, if present, is very small. The spindle attachment of the *X* is subterminal and is believed to lie in the pairing segment, so that crossing-over may occur on either side of it. The region between the centromere and the non-pairing (differential) segment is a quarter to a half that of the whole pairing region in which crossing-over will take place. Genes in this part of the *X* will show incomplete sex linkage, the linkage being lowest in loci farthest from the non-pairing segment. Both symmetrical and asymmetrical sex bivalents were found, and the *X* and *Y* sometimes fail to pair. In one individual chromatid bridges and fragments were observed. He was probably heterozygous for an inversion. Such inversions may yet prove to be of significance in the racial differentiation of man.

Barbels of Japanese Fish

THE structure and function of the barbels of two Japanese fish have been investigated by Mitus Sato (Sci. Rep., Tôhoku Imp. Univ., Feb. 1937, 3 papers). One, the goatfish, *Upeneoides bensasi*, has two long barbels on the chin, and the other, a sea catfish, *Plotosus anguillaris*, has four pairs of barbels, two pairs above and two below the mouth. The barbels in both fish have a central supporting cartilaginous rod and in the epidermis covering them lie a number of characteristic taste organs which are supplied by branches of the fifth and seventh cranial nerves. In the catfish such organs are also to be found in the lips. These organs are more important than either sight or smell in the selection of food. In the goatfish the removal of the barbels causes a loss of the power to distinguish food. This does not occur in the catfish, since some of the organs are left in and around the lips.

Chromosomes of Coffee Plants

A STUDY of the chromosomes of *Coffea* has been made by Dr. C. A. Krug (*J. Genetics*, **34**, No. 3), who confirms that $2n = 22$ in *Coffea arabica* and has found the same number in seven other species. Most of the cultivated varieties of *C. arabica*, however, are tetraploids; while the var. *bullata* of Cramer, which has broader and much thicker leaves, is an autooctoploid ($2n = 88$) or in certain plants hexaploid. The octoploid condition also arises somatically on a branch of a tetraploid, and can revert somatically to the tetraploid. Hexaploids are much less frequent, so it is concluded that the octoploids probably arise through chromosome doubling after fertilization. Their fruits are abnormal, giving a very low percentage of germination. All the offspring were $4n$ except one $6n$ and one $8n$. The $4n$ plants may have arisen parthenogenetically. The pollen meiosis in the octoploids is irregular, only about 62 per cent of the tetrads having four microspores. From $4n \times 8n$ seven plants were obtained, all having $2n = 44$. These must have arisen from parthenogenesis or by the fertilization of $2n$ eggs by $2n$ pollen. The hexaploids also show high gametic sterility and low seed production. Four seedlings were produced, three of which had 66 chromosomes and one 44. In reciprocal crosses between *C. arabica* ($2n = 44$) and *C. canephora* ($2n = 22$) a triploid hybrid plant produced misshapen seeds with little or no perisperm but with normal embryo. *C. canephora* has several chromosomes longer than the rest, and these are recognizable in the hybrid.

Petrofabric Study of Moine Schists

AT the meeting of the Geological Society on May 5, F. C. Cole presented an important paper dealing, for the first time, with the application of petrofabric analysis to the problems of the metamorphic rocks

of the Highlands. In all, 85 analyses of quartz and mica fabrics of Moine schists have been made. Specimens collected over a wide area have given in every instance a well-marked girdle-diagram, indicating that the schists are typical *B*-tectonites. In these, the direction normal to a girdle, known as the *b*-axis or tectonic axis, has the same significance as a visible fold-axis. The *b*-axes of the Moines pitch uniformly into the south-east quadrant, suggesting that the present regional metamorphic condition of the Moines is the result of movements along approximately south-west and north-east lines. The effect of the post-Cambrian overthrusting on the fabric of the schists is also examined. Relics of the earlier fabric are traceable in partially mylonized rocks, but the thrust movements have had little or no constructive effect, being in the main cataclastic, and the continuity of the structure is lost. The evidence indicates that the general metamorphism of the Moine schists was effected by movements, earlier than the overthrusting phase of the Caledonian orogeny, acting in a direction almost at right angles to the direction of overthrusting, but parallel to pre-Torridonian directions of movement in Lewisian areas.

Drilling of a Deep Pressure Test in India

EXPERIENCE has shown that problems pertaining to the drilling of a well under pressure to great depth are many and formidable. The main difficulties to be overcome are shallow zones of low-pressure sands, which cause loss of fluid and circulation, deeper high-pressure water and gas sands, 'heaving shale' formations and hard formations, which retard drilling and are conducive to crooked holes. Mr. G. F. Wilson, in a paper presented to the Burma Branch of the Institution of Petroleum Technologists on May 4, described measures which have been adopted to overcome these particular difficulties when drilling a deep well in India. The casing was set below the low-pressure zone; heavy mud was used as well as pressure drilling; by continuous maintenance of pressure and the use of treated muds, heaving shale formations were penetrated and the effect of hard formations counteracted so far as possible by provision of a hydraulic table. The history of this test well showed that pressure drilling is quite practicable for prolonged periods, providing the best obtainable equipment is used. Where, however, rock pressures are known and can be dealt with by mud, it is better not to employ pressure drilling, but to keep it as a standby, since the increased cost of fuel and equipment for drilling under pressure is in most cases greater than that of mud-loading materials.

Crystalline Structure of Pentaerythritol

THE elucidation of the structure of sugars by X-ray analysis has been hampered by lack of knowledge of various interatomic distances. F. J. Llewellyn, E. G. Cox and T. H. Goodwin (*J. Chem. Soc.*, 883; 1937) have made an analysis of the relatively simple compound pentaerythritol, $C(CH_2.OH)_4$, which shows that the model consists of a central carbon atom surrounded by four CH_2 groups at the corners of an almost exact tetrahedron; each hydroxyl group is attached to its CH_2 by a bond making nearly a tetrahedral angle with the C—CH_2 link, and is so directed that the four OH groups lie at the corners of a square. The bond lengths and angles were calculated from the measured atomic co-ordinates and cell dimensions, the distances being C—C = 1·50 A. and C—O = 1·46 A., the first being slightly less than that found in diamond and usually assumed for aliphatic compounds, and the second almost exactly equal to the calculated sum of the half-bond lengths of carbon and oxygen. The structure of the lattice as a whole is of a very pronounced layer type, the molecules being linked together by hydroxyl bonds in sheets in the (002) planes, and the separation of more than 3½ A. accounting for the perfect cleavage parallel to {001}. The evidence supports the view that the relatively short distance between hydroxyl groups represents a hydroxyl bond in which a hydrogen atom binds two oxygen atoms closely together while remaining attached essentially to one of them. The arrangement is very similar to that found in resorcinol. All other inter-molecular distances are much greater and correspond with relatively weak van der Waals' forces.

Determination of Lactoflavin in Milk

A RAPID method for the determination of lactoflavin (vitamin G) in milk by a fluorimetric method is described by C. H. Whitnah, B. L. Kunerth and M. M. Kramer (*J. Amer. Chem. Soc.*, **59**, 1153; 1937). To 10 ml. of milk, 15 ml. of 10 per cent trichloracetic acid is added, the mixture is allowed to stand for ½–1 hour and centrifuged for 5 minutes at 2,000 r.c.f. Ten ml. of the resulting serum is neutralized with methyl orange as indicator and diluted until the sample can be matched in the light of an Eveready Fluoray lamp with standard flavin solutions (Labco *PX* grade) containing 0·12–0·06 gamma of flavin per ml. The consistency of the method was confirmed, and comparisons with the biological assay by the Bourquin-Sherman method were satisfactory. Attempts are being made to apply the method to colostrum, which is higher in lactoflavin content than normal milk.

Classification of Stellar Spectra

THE spectral classification of stars of types *A* to *K* has recently been discussed by W. W. Morgan (*Astrophys. J.*, **85**, 380), who points out the desirability of a two-dimensional system of classification depending on effective temperature and luminosity. The system should be in empirical units based on the actual observed criteria in the spectra, so that no errors are introduced by assumptions involved in reducing these to values of the corresponding physical parameters. The Henry Draper notation provides a suitable method of classification in the temperature direction which is practically constant for all values of the surface gravity in the stars considered; but the criteria on which it is based should be as far as possible independent of a star's luminosity. Classification in the luminosity direction should similarly be based on lines which are unaffected by temperature over the range in which they are employed. The author suggests, as simple criteria which fulfil these conditions, some single line intensities, intensity ratios and differences. They enable the H.D. type to be determined with high accuracy, and (for types *A*7 to *K*9) give an additional numerical classification directly related to luminosity. The criteria for types *A*0 to *A*6 are not sufficiently accurate to give more than a 'group' classification (for luminosity) into super-giants, main sequence stars and white dwarfs.

The Bone-Bearing Beds of Bethlehem: Their Fauna and Industry

By Elinor W. Gardner and Dorothea M. A. Bate

IN a note in 1934 (NATURE, Aug. 11, 1934, p. 219) one of us (D. M. A. B.) directed attention to an interesting discovery of elephant remains in a deposit at Bethlehem. This was the result of a cursory examination on the spot undertaken for the Department of Antiquities.

Shortly afterwards, the late Sir Henry Wellcome became interested in the site, and a concession was obtained by Mr. J. L. Starkey from the Department of Antiquities, Palestine, for the Wellcome Archæological Research Expedition to the Near East. In the spring of 1935 the Geological Section of the above Expedition began its first season's work with E. W. Gardner as geologist and D. M. A. Bate as palæontologist. It was continued in 1936 under the same auspices, and resumed in 1937, thanks to the enthusiastic support of the trustees of the late Sir Henry Wellcome and of Sir Robert Mond.

GEOLOGY

The bones were first found by the owner of a garden digging for water on the highest point of Bethlehem, 790 m. above sea-level. On all sides the ground falls away, on the east towards the Dead Sea Rift, on the west towards the Mediterranean.

The position of the deposit isolated on the highest part of the Judæan arch at once, therefore, aroused interest, for the solution of the problem of its origin would certainly throw interesting light on the past physiography of the region and its relation with the Rift Valley and Transjordan.

In the original pit, elephant bones were seen *in situ* at 15 m. below the surface. On opening up the area they were found some 6 m. down in a coarse gravel with a stiff clay matrix, which makes their extraction a slow and difficult business. The gravel consists mainly of chert of all sizes, some blocks being half a metre or more big. Limestone is a minor constituent, but is locally abundant. A few iron nodules are also found. The materials are very little sorted, and are mostly derived from local Cretaceous rocks, with the exception of the iron nodules, which are more characteristic of the Eocene.

As the excavation was enlarged it seemed in the first season as though there were two gravels separated by a bed of pure clay, all dipping east, but later work showed that in depth the two gravels coalesce. They are both bone-bearing, in contrast to the pure clay, which has never yet yielded any remains.

Those in the western gravel are badly preserved, perhaps because they occur nearer the surface and are less protected by deposit of lime or nari towards the top. An interesting specimen found there was a jaw of an elephant, and perhaps part of the skeleton. The mass of bone, 3 m. long, dipped, with the beds, steeply to the north-east; while some of the deposits in the north-east corner—the original area—dip as steeply (±40°) to the south.

In 1935 no junction of the gravels and clays with country rock was found, and therefore in 1936 the area was enlarged in the hopes of finding one.

On the east and south a white chalky rock, nari with lumps of limestone, had already been sporadically uncovered, and on cutting back the south side it increased rapidly both vertically and laterally. In places it arches over the gravel, sometimes with a very clean junction. It is veined with red clay, which in places develops into pipes narrowing upward, and mostly dipping eastward. In depth blocks of limestone, some with fossils, become more and more abundant and of increasing size. The surface of these is weathered sub-aerially, and often shows characteristic carving and fretting.

Fig. 1.

The gravel in the west lies on this deposit, which may be called a cemented scree or breccia, at a steep angle, and sometimes penetrates into it as pipes. The approach of the scree is heralded by increasing numbers of limestone boulders in the gravel and by the reddening of the clay. In the east and south-east, on the other hand, the junction is sharp and vertical, or nearly so, the gravel and clay fall away under the pick in big masses, leaving a clean face of white rock. In the same area vertical or steep clay faces are exposed in the same way, and these, if not on the junction, are always very near it.

On the south the steep scree face has been followed down for 11 m., at which depth it flattens out into a small platform before plunging down again. From the northern edge of this platform a hard triangular mass of breccia rises two metres above the floor. The space between it and the southern wall was filled

with grey bone-bearing gravelly clay, which ended quite abruptly against the breccia block. A somewhat similar but smaller mass has been found in the north-west corner. The irregularity of the surface of the scree deposit, together with the nature of the junction with the bone-bearing beds, seems to indicate that it was formed before them and that they were laid down on and against it.

In the south-east corner yet another curious deposit was found. This consisted of a pipe—3 m. broad—in the nari and scree, filled with blocks of chert of all sizes, some more than a metre in all dimensions. In contrast to the chert in the gravel, which is more or less worn, these blocks of whatever size are sharply angular.

The pipe slopes in the north-east and ends some 6 m. down after narrowing slightly, and finally disappears in the narrow cracks of the cemented scree. On the south side of the pipe near the base the scree contained some remarkable polished cherts. They were found in pockets of red clay in the scree and were mixed with quite unworn and angular fragments. The polish is so high that it is more like a glaze. In some cases the cherts are intensively worn, in others and more frequently, they are less so and show numerous flake scars.

It is still too soon to discuss the origin of all these materials, but there can be little doubt that the gravel and clay bone-bearing series is a water-laid deposit, and that the bed against which it rests is a sub-aerial one.

The gravels are rapidly contracting in area as they go down and this, in conjunction with the inward dip, points to the filling of a roughly funnel-shaped hole, or alternatively to the collapse of the original floor on which they were laid. Whatever may be the ultimate decision, the impossibility of any such deposit forming in its present position indicates wide physiographic changes, which in their turn point to a great age. More exact dating must be left to the palæontologist.

Archæology

It is possible, however, that some help in the dating problem may be obtained from implements. Throughout the work a close watch has been kept for human worked flints, but until this year nothing definite was found. Now, however, a number of possible tools have been obtained, in the bone-bearing gravel, and these, if accepted, will be invaluable not only in dating, but also in helping to trace the deposits elsewhere.

Miss Caton-Thompson, who saw them *in situ*, and has kindly consented to work them out, contributes the following note :

"The cherts in the deposit have a wide variation in size, ranging from huge blocks to small chips and pebbles. Both tabular and nodular varieties are present. The former is mainly represented by a pale greenish chalcedonic chert with a rough or corrugated cortex ; the latter by a dark grey-to-black 'chalk flint'. A peculiar local variety, favoured on certain sites by Acheulean man for hand axes, is also included ; it has the appearance of an angular puddingstone, and is known as brecciated chert.

"The play of mechanical forces on the flints is strikingly evident. Striations, shattering, bruising, crushing, rolling and thermal action are all visible. Taken as a whole, however, rolling is very slight compared with normal gravel constituents, and a considerable proportion of the material is relatively fresh.

"The danger of claiming humanly-fashioned tools from such an assemblage and so vast a selection is obvious. Nevertheless, we think that a certain number of pieces are difficult to explain in other terms. They will provoke healthy controversy as acute as that which has beset the 'artefacts' from the Red Crag of Foxhall, or the sub-Crag detritus bed flints at Bramford. Many of the Bethlehem 'artefacts' resemble the latter, in so far as both, when of tabular flint, conform closely in shape and edge trimming to the classic type of Harrisonian eolith. This is the first time they have been found in a sealed deposit in Palestine or the Near East, though Mr. Starkey has long known them from the bed of Wadi Ghuzzah. Flakes, though rarer, are also present, and display 'striking platform' and/or bulb.

"Balancing the probabilities, we think the type of flaking and edge trimming exhibited on these admittedly selected specimens is less easy reasonably to explain as the accidental work of natural forces, than as the deliberate experimental work of man in remote pre-Chellean times." E.W.G.

Palæontology

The first discovery of fossil elephant remains in Palestine was announced in NATURE of August 11, 1934, p. 219. Subsequent finds have been made in the Wady Mughara caves and in the bed of the River Jordan not far from its exit from Lake Huleh, but both these are of later date than the deposit at Bethlehem which yielded the first remains. In fact, with the possible exception of a single specimen which I hope to describe shortly, the Bethlehem deposit has yielded a mammalian fauna of earlier geological age than any so far known from Palestine. As yet it has been possible to make only a preliminary examination of the animal remains obtained during the three seasons' work ; this has revealed the presence of the following vertebrates :

Felis sp. (size of *Panthera leo*)	*Rhinoceros* cf. *etruscus*
Hippopotamus sp.	*Stegodon* sp.
Bos sp.	*Elephas* sp.
Antelope	*Testudo* sp. (of gigantic size)
Giraffoid	*Testudo* sp. (of very small size)
Hipparion sp.	

Besides the above species there is known to be a small carnivore, but its remains are extremely fragile and have not yet been extracted from the matrix. With, perhaps, the exception of the large *Felis*, the *Bos* and the tiny tortoise, all these species are new to Palestine, and without doubt represent extinct forms.

Among the mammals the name *Bos* is used in a broad sense, since the species is known only from portions of horn cores. Likewise the antelope and the Giraffoid are only represented by a small number of skeletal remains. The discovery of *Hipparion* is of special interest, both chronologically and geographically. Species are known from many Tertiary deposits in Asia, including India, and are generally considered to be typical of the Pliocene. Last year (1936) Father Teilhard de Chardin and Prof. de Terra recorded *Hipparion* remains from the Basal Pleistocene of India, although they themselves did not wish to claim this dating as proved conclusively. The find at Bethlehem seems to suggest that further corroboration may be forthcoming from India. In

East Africa, on the other hand, *Hipparion* remains are well known from Pleistocene deposits, and have been recorded from Oldoway, Beds I–IV, from Kaiso and from Lake Rudolf.

The Bethlehem *Rhinoceros* has been compared with *R. etruscus*, since some of the upper cheek teeth appear to be similar; the height of the crowns is, if anything, slightly less in the Palestine specimens. In this connexion it is of interest to remember that the late Dr. W. D. Matthew compared the Indian *Dicerorhinus platyrhinus* with *R. etruscus*.

The discovery of the *Stegodon* remains is of outstanding moment. This is essentially an Asiatic genus, though Dr. A. T. Hopwood allows me to mention that its occurrence in African deposits is now known and will shortly be published. India during the Pliocene appears to have been the great centre for the adaptive radiation of the *Stegodon* group. Here the genus lingered on into the Middle Pleistocene; in Java it is known from an even later horizon. As might be expected, the *Elephas* from Bethlehem is represented by a primitive form with low-crowned cheek-teeth.

The gigantic tortoise is known from a considerable number of plates from the bony carapace and plastron. Most of these were collected early this year and have not yet been examined critically. It will be remembered that remains of a gigantic tortoise were discovered by Dr. Leakey in East Africa in 1935.

Many of the animal remains have been subjected to pressure, and this corroborates the geological evidence that movements must have taken place after their inclusion in the deposit. Frequently it has seemed evident that complete carcases have been embedded in the deposit, notably in the case of the elephant quoted above by Miss Gardner. Likewise it may be mentioned that so far the animal remains have given no indication of a difference of fauna from different parts of the excavation.

Unfortunately, owing to local conditions, specimens are generally very fragile, and always difficult to extract. It is hoped, however, that further work next spring may result in the acquisition of still larger collections, which will enable us to extend our knowledge of this new fauna.

In conclusion, it is suggested for the Bethlehem fauna that its origin is Asiatic, and that its age is not later than Early Pleistocene, using this term palæontologically as indicating the time of arrival of true *Bos*, *Elephas*, and *Equus*. The fauna also indicate a warm climate, with a more liberal supply of permanent water than is found in the country at the present day. Further, it is claimed for this fauna that it will provide a faunistic link for this period between Asia and East Africa, enabling a better understanding to be reached regarding the migrations and centres of dispersal of various mammalian groups.

D. M. A. B.

The Lake District as a National Park

THE question of the afforestation projects which are being carried out by the Forestry Commissioners has been the subject of considerable controversy and alarm among residents of the Lake District and those who have an admiration for this beautiful piece of England.

The Friends of the Lake District have recently published a pamphlet entitled "Make the Lake District a National Park" (Ambleside: Friends of the Lake District. Sec., 2 Midland Bank Chambers, 1937), which is, in effect, an appeal to all lovers of the Lake District based on a new method of treating and preserving this unique region without involving any of the upset to local agricultural methods which is one of the strong objections offered to the Forestry Commission's activities. The pamphlet opens with the sentence, "Regions of great natural beauty have a lasting value for the refreshment and inspiration of man." The object of the proposal to create the area a national park is to preserve for the future the outward aspect of the district as at present seen "with the grand and the beautiful in splendid harmony". The formation of a national park does not necessarily entail the nationalization of ownership. "The policy has no quarrel with the essentials of the present system of land holding, or with the enjoyment of private property as such. It can be achieved inside the traditional framework."

One of the great objections to the afforestation proposals of the Forestry Commission has been the disturbance involved to local methods of agriculture, and especially to the famous strain of Herdwick sheep. The fells of the Lake District are rough grazing, occupied by Herdwick sheep; and, since there is no conflict of interest between sheep and the pedestrian, the local agricultural system and free access, it is said, are good partners.

The valley bottoms are not arable, but grass land with a generous lay-out of footpaths on the 'inside land'; the meadows do not run far up into the dale-heads, nor do the 'intakes' run far up on to the hill-sides. The whole configuration and covering of the land is, given moderately free access, ideal for the formation of a national park. The tourist industry, second in importance only to the sheep, will greatly benefit and thus assist the local hardy inhabitants to enjoy a greater prosperity.

The Lake District extends over parts of the three counties of Lancashire, Westmorland and Cumberland. There are seven planning authorities in the Lake District and half a dozen highway authorities, while the Forestry Commission possesses full powers overriding most of these. In order to secure uniformity, the proposal made by the Friends of the Lake District is that a National Park Commission should be appointed by the Government with statutory powers for protective purposes to override other bodies; that the Commission should receive a grant from the taxpayers' money and that it would be responsible to Parliament only. In return for the outlay the public, by arrangement with the landowners and commoners, would acquire a right to utilize all paths, etc., which have for long been frequented by the courteous permission of such proprietors and commoners. Any other national parks created in the country would be placed under the general control of the National Park Commissioners.

Science News a Century Ago

The Insulating Power of Fluids

IN 1837, Faraday was making researches connected with the induction, and the conduction of electricity by various types of insulators. As is generally known, his observations were entered in his diary in numbered paragraphs, the entries for September 6, 1837, running from No. 3875 to No. 3891. The first few of these were as follows:

"3875. Tried insulating power of some fluids by dipping a glass rod in them and then touching a gold leaf electrometer with the wet part, the finger being also applied to the wet part about the third of an inch from the electrometer. Thus a film of the liquid of about half an inch long formed the communication.

"3876 *Oil of turpentine*—good and filtered; insulated well.

"3877 Oil of turpentine—old and with water at the bottom of the bottle; discharged the electrometer at once.

"3878 *Naphtha (french)*—insulated well.

"3879 *Oil gas liquid*— Do.

"3880 *Caoutchoucine*—discharged moderately.

"3881 Cocoa nut oil (the expressed solid part)—discharged at once.

"Hence Oil of turpentine, Naphtha and Oil gas liquid appear as if they would do for transinductive media."

Discovery of the *Victoria regia*

AT a meeting of the Botanical Society held on September 7, 1837, the secretary read a communication from Robert H. Schomburgh dated New Amsterdam, Berbice, May 11, 1837, on a new genus allied to the water-lily, which by permission of Her Majesty he had named *Victoria regia*. The discovery of the plant by Schomburgh, in the River Berbice, in British Guiana, was made in January. When on the river he saw something which raised his curiosity, "All calamities were forgotten; I felt as a botanist and felt myself rewarded. A gigantic leaf, from five to six feet in diameter, salver-shaped, with a broad rim of light green above, and a vivid crimson below, resting upon the water: quite in character with the wonderful leaf was the luxuriant flower consisting of many hundred petals. The smooth water was covered with them, I rowed from one to another, and observed always something to admire. . . . We met them afterwards frequently, and the higher we advanced the more gigantic they became".

British Association at Liverpool

ON Saturday, September 9, 1837, the General Committee of the British Association met in the library of the Liverpool Athenæum, the Marquis of Northampton being in the chair. In the course of the meeting it was announced that the Government, at the request of the council, had consented to repeal the duty on the importation of philosophical instruments, and also to extend the Ordnance Survey to Scotland. It was also stated that the council had directed its attention to the establishment of a law of universal copyright, and had entered into communication with M. Guizot, Minister of Public Instruction in France, and Mr. Sergeant Talfourd.

It was submitted and agreed to that admission to the General Committee, then open to the presidents and vice-presidents and office-bearers of charter philosophical societies and contributors to the *Tra actions*, should be extended to the officers of t Literary and Philosophical Society of Newcastle, t Natural History Society of Newcastle, the Werneri Society of Edinburgh, the Royal Geological Society Cornwall, the Geological Society of Dublin and t Statistical Societies of London and Manchester.

Babbage's "Bridgewater Treatise"

IN May 1837, Babbage published "The Nin Bridgewater Treatise. A Fragment". It was s versely criticized in the *Mechanics' Magazine* September 9, 1837, in which it was said that "almo every chapter is composed of mere scraps of co position, without any attempt to unite them in one whole; some chapters have no end; many m have no beginning and one at least might be fai said to have neither beginning, middle nor end. . It is perhaps hardly necessary to do more", said t reviewer, "than state the plain fact that the m object of this Ninth Bridgewater Treatise is p fessedly to *raise our conception of the power and wisd of the Creator, by comparing the mechanism of Universe with that of Mr. Babbage's calculating engin*

Indulgent Examiners

THE *Lancet* of September 9, 1837, contains t following story from a correspondent, entitled New Method of Passing Apothecaries Hall": "C didates who are rejected are most strongly reco mended to commence *crying* immediately after t sentence of the Examiners is pronounced; this m of appeal to the worthies of the Hall being likely prove effectual for candidates in that predicame A case in point occurred last week. A great b on the wrong side of thirty left the room crying alo The sentimental event touched the feelings of examiners and the scientific youth was called ba after a few minutes into the presence of the Boa whence he returned to the 'funking' room with diploma, where he commenced kicking up his he and laughing most uproariously, and finally plac his dexter thumb to the point of his nose, in expressive manner, quitted the Hall, perplexed mu to know whether the operation of sneering or laugh was most suited to the occasion".

Preservation of Bodies for Dissection

THE issue of the *London Medical Gazette* for Septe ber 9, 1837, contains the following description of method of preserving bodies for dissection inven by M. Gannal, to whom the Academy of Sciences Paris awarded a prize of 8,000 francs: "The proc simply consists in injecting an aqueous solution of aluminous salt by one of the carotids; some pi are sufficient; after it the body may be preser exposed to the air for a long time without pu faction, and sometimes at last dries and is mummif He uses acetate of alum prepared from the acet of lead and sulphate of alum and potash; and or six pints of a strength that will mark 18° Beaumé's aerometer, are sufficient to preserve a b for five or six months. He has also used sim sulphate of alum for procuring the acetate. W one kilogramme of common sulphate of alum lumps, 250 grains of acetate of lead and two p of water, a mixture may be obtained sufficient preserve a body four months; or common sulph of alum alone will make one keep for two months"

University Events

CAMBRIDGE.—At King's College, K. P. Harrison and O. L. Zangwill have been awarded Harold Fry studentships, and D. S. Evans has been awarded a Martin Thackeray studentship. At Clare College, Denman Baynes research studentships have been awarded to J. V. Dunworth and T. E. Easterfield for natural sciences and mathematics respectively. At Emmanuel College the external research studentship offered to graduates of other universities intending to commence residence as research students in October next has been awarded to A. G. Ward (Queen's University, Ontario) for research in physics.

DURHAM.—The title of emeritus professor has been conferred on Prof. W. M. Thornton from the date of his retirement at the end of the session 1936–37. Prof. Thornton has been professor of electrical engineering since 1906.

Dr. Emrys Williams has been appointed lecturer in electrical engineering in succession to Dr. J. A. Wilcken, who has resigned, upon his appointment as assistant editor of *Science Abstracts* issued by the Institution of Electrical Engineers.

Societies and Academies

Paris

Academy of Sciences, June 28 (*C.R.*, 204, 1909–1992).

ALFRED LACROIX : A new basaltic type, comparable, from the chemico-mineralogical point of view, with the felspathic meteorites.

MME. HILDA GEIRINGER : Chance variables arbitrarily connected. Case of convergence according to the law of Gauss.

FUMIMOTO MAEDA : Nuclei of the Fourier type.

LÉON BESCHKINE : The general solution of rectangular plates (plane problems).

JEAN ROUBAUD-VALETTE : A generalization of the operation of Dirac.

GEORGES DARRIEUS : A new form without singularities of the electrodynamic of Born.

ALEXANDRE DUFOUR and FERNAND PRUNIER : The observation of the Sagnac phenomenon by an immobile observer.

JEAN LECOMTE, HENRI VOLKRINGER and ARAKEL TCHAKIRIAN : The infra-red and Raman spectra of the chlorobromomethanes.

PIERRE MESNAGE : The molecular emission spectra of some metallic salts.

H. BIZETTE and M. SCHÉRER : Anomalies of the magnetic rotatory dispersion of sulphuric acid solutions of tellurium.

MAURICE COTTE : The calculation of the influence of the space charge in electronic optics.

JACQUES SOLOMON : The origin of the quadripolar moments of the atomic nuclei.

MAURICE DODÉ : The dissociation of native zinc carbonate, a reaction in which a mixed condensed phase intervenes.

RENÉ DELAPLACE : The vapour pressure of gaseous saturated hydrocarbons at low temperatures in the presence of silica gel. Pressures are given for methane, ethane, propane, normal and isobutane at temperatures ranging from −25° C. to −171° C. Some quantitative separations of these hydrocarbons can be carried out by this method.

JEAN COURNOT and MLLE. LOUISE HALM : Studies on the corrosion of magnesium and some ultra-light alloys protected by deposits on the surface.

MME. LÉONE WALTER-LÉVY : Magnesium basic chlorocarbonate.

M. LEMARCHANDS and P. PIERRON : The action of bromine on yellow mercuric oxide.

MAXENCE MEYER : The thermal decomposition of the αα-diethoxydiacids.

JULIEN DURAND : The major irregularities of the crystalline country of Rouergue and of Albigeois.

RENÉ ABRARD and EDGAR AUBERT DE LA RÜE : The existence of the upper Neogene with *Cycloclypeus* at the islands of Epi and Malekula (New Hebrides).

EUGÈNE RAGUIN and HENRI VINCIENNE : An exceptional (hypothermal) type of lead-bearing deposit in the Montagne-Noire.

MLLE. JANE MANUEL : The sexuality of the principal species of the genera *Saccharomyces*, *Hansenula* and *Pichia*.

LOUIS BOUNOURE : The constitution of the genital glands in the russet frog after extensive destruction of the germinal line by the action of ultra-violet rays on the egg.

GEORGES CARRIÈRE, PIERRE JEAN GINESTE and EMILE LAINE : The action of the thyroid body on the thymus.

STEPHAN JELLINEK : Cells with regular geometric deformations without traces of heat action. The action of ultra-short waves (6 metres, 500 watts) on the larvæ of *Salamandra maculosa*.

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Academy of Sciences, *C.R.*, 15, No. 3, 1937.

N. ACHYESER and M. KREIN : The best approximation of periodic functions derived by summation of trigonometric series.

H. HILMY : The theory of quasi-minimal ensembles.

R. O. KUZMIN : The distribution of values of some arithmetical functions.

B. FESSENKOFF : (1) Eclipses of the moon and the distribution of atmospheric ozone. (2) The infinite universe and the luminosity of the night sky.

N. A. ŠIŠAKOV : An investigation of structures of silica glass, pozzolans and clays by means of electron diffraction (see also NATURE, May 29, p. 927).

S. ŠUBIN and A. SMIRNOV : The scattering of light by the electrostatic field of a point charge from the point of view of the non-linear quantum electrodynamics.

L. I. BELAJEV : Pseudo-extraction and some specific properties of films obtainable thereby.

M. I. DEMENTJEVA, A. V. FROST and E. K. SEREBRIAKOVA : Equilibrium hydrogenation of *n*-butylenes to butadiene, $n\text{-}C_4H_8 \rightleftarrows C_4H_6 + H_2$.

A. S. SEREBROVSKIJ : Analysis of the allobalance of a chromosome by two markers. Utilization of several quantitative characters simultaneously.

M. F. TERNOVSKIJ : Amphidiploid shoots of the F_1 hybrid *Nicotiana tabacum* L. × *N. sylvestris* Speg. et Comes.

V. P. OSTRJAKOVA-VARŠAVER : *Galleria melonella* L. as a new material in genetical investigations.

O. J. SOBOLEVSKAJA and V. S. BUTKEVIČ : Formation of citric acid in the makhorka leaf (*Nicotiana rustica* L.).

Forthcoming Events

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (NOTTINGHAM MEETING).

Sunday, September 5

At 8.15 p.m.—Prof. H. Hartridge, F.R.S.: "Illusions of Colour" (Public Lecture at Nottingham).

Monday, September 6

At 10 a.m.—Prof. D. Brunt, Dr. K. C. Lange, Prof. V. Vaisala: "The Upper Atmosphere" (Symposium: Section A).

Dr. Irving Langmuir, Dr. H. Eyring, Prof. H. S. Taylor, F.R.S., Prof. E. K. Rideal, F.R.S., Dr. J. F. Danielli, and Dr. H. J. Phelps: "Surface Action in Biology" (Joint Symposium: Sections A, B and I).

Prof. A. Plant, Prof. B. F. Shields, H. T. Weeks, H. G. Selfridge, jun.: "Retail Distribution" (Discussion: Section F).

Dr. W. B. Turrill, W. J. C. Lawrence, Prof. J. R. Matthews, Dr. T. J. Jenkin and Dr. J. W. Gregor: "Genetics and Taxonomy" (Discussion: Section K).

At 11.30 a.m.—Prof. H. Levi, J. Sargent and J. Wickham Murray: "Technical in Relation to General Education" (Discussion: Section L).

At 2 p.m.—Prof. P. M. Roxby, Dr. L. Dudley Stamp and Prof. C. B. Fawcett: "Culture Regions" (Joint Discussion: Sections E and H).

At 7.30 p.m.—T. M. Herbert: "The Transport of Food (Public Lecture at Newark-on-Trent).

At 8 p.m.—Sir Gilbert Walker, F.R.S.: "The Mechanics of Sport" (Public Lecture at Derby).

Dr. J. E. R. Constable: "Science in Everyday Life" (Public Lecture at Long Eaton).

At 8.30 p.m.—Prof. J. Gray, F.R.S.: "The Mentality of Fishes" (Evening Discourse).

Tuesday, September 7

At 10 a.m.—Dr. R. E. Stradling, Dr. F. M. Lea, Dr. J. S. Dunn, F. H. Clews, H. H. Macey and Dr. G. R. Rigby, Dr. D. G. R. Bonnell: "Chemistry of Building Materials" (Symposium: Section B).

Prof. Winifred Cullis, Dr. H. Magee, Prof. R. C. Garry, Dr. L. P. Lockhart: "Physiology as a Subject of General Education" (Section I: Discussion).

Sir John Russell, F.R.S., Dr. Winifred Brenchley, W. Davies, G. E. Blackman, and Mr. Martin Jones: "Pasture Problems" (Joint Discussion: Sections K and M).

At 8 p.m.—Dr. L. Dudley Stamp, Prof. H. L. Hawkins, F.R.S., Dr. J. S. Huxley, Prof. E. J. Salisbury, F.R.S., Sir Daniel Hall, K.C.B., F.R.S., Prof. J. H. Jones: "Planning the Land of Britain" (Joint Discussion: Sections C, D, E, F, K and M).

INSTITUTE OF METALS, September 6–9.—Annual Autumn Meeting to be held at Sheffield.

September 6, at 8.—Dr. D. R. Pye, F.R.S.: "Metallurgy and the Aero Engine" (Autumn Lecture).

Appointments Vacant

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

ASSISTANT ENGINEER in the Research Department, Woolwich, S.E.18—The Chief Superintendent (September 10).

LECTURER IN MINING ENGINEERING in the Denbighshire Technical Institute, Wrexham—The Secretary and Director of Education, Education Offices, Ruthin (September 11).

CROMBIE-ROSS LECTURER IN PSYCHO-PATHOLOGY in the University of Aberdeen—The Secretary (September 15).

JUNIOR LECTURER IN PHYSICS in the Military College of Science, Woolwich, S.E.18—The Commandant (September 17).

DEMONSTRATOR IN CHEMICAL PATHOLOGY in the University of Leeds—The Registrar (September 18).

STATE CHEMIST FOR IRELAND—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (September 24).

ASSISTANT IN BIOCHEMISTRY in the University of Oxford—The Whitby Professor of Biochemistry (September 20).

JUNIOR ASSISTANT in the Science Museum Library—The Director, Science Museum, South Kensington, S.W.7 (October 4).

LECTURER IN PHYSICS AND MATHEMATICS in the College of Technology and Art, Rotherham—The Director of Education, Education Office, Rotherham.

Official Publications Received

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1936. Pp. v+235. (London: H.M. Stationery Office.) 3*s.* 6*d.* net. [11

National Institute of Poultry Husbandry. Bulletin No. 13: Table Duck Production. By A. J. Macdonald and Jean W. T. Kay. Pp. 12 (Newport, Shropshire: Harper Adams Agricultural College.) [11

National Advisory Council and the Grants Committee for Physical Training and Recreation. National Fitness: the First Steps. Pp. 24 (London: H.M. Stationery Office.) 2*d.* net. [11

National Institute for Research in Dairying, 1912–1937. Twenty-fifth Anniversary Review. By the Staff of the Institute. Pp. 59+xxi (Shinfield: National Institute for Research in Dairying.) [12

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1764 (2509): On the Application to Tubular Frameworks of the Method of "Systematic Relaxation of Constraints". By Macdonnell W. Woods and E. J. Warlow-Davies. Pp. 22. 3*s.* net. No. 1765 (2467): On Reynolds Numbers of Transition. By A. Fage. Pp. 14. 2*s.* net. No. 1767 (2706): Abstract of a Film illustrating the Theory of Flight. By Dr. H. C. H. Townend. Pp. 8+8 plates. 3*s.* net. No. 1769 (2713): Induced Drag due to Washout. By C. N. H. Lock. Pp. 5. 1*s.* net. No. 1773 (2628): Note on the Design of Corners in Duct Systems. By Dr. G. N. Patterson. Pp. 16+1 plate. 2*s.* 6*d.* net. (London: H.M. Stationery Office.) [16

Graduate Employment: a Report of the 1937 Congress of the National Union of Students of England and Wales and the Preparatory Investigation for the Congress. Pp. 94. (London: National Union of Students.) Free. [16

Department of Scientific and Industrial Research. Report of the Building Research Board; with a Report of the Director of Building Research for the Year 1936. Pp. vi+210+25 plates. (London: H.M. Stationery Office.) 4*s.* net. [16

Ruskin and Brantwood: an Account of the Exhibition Rooms. By J. Howard Whitehouse. Pp. 44+8 plates. (Bembridge: Ruskin Society.) 2*s.* net. [16

Other Countries

Koninklijk Nederlandsch Meteorologisch Instituut. No. 102. Mededeelingen en Verhandelingen, 40: Het Klimaat van Nederland (The Climate of the Netherlands). F: Zonneschijn en Bewolking (Sunshine and Cloudiness). By Dr. C. Braak. Pp. 52. ('s Gravenhage: Rijksuitgeverij.) 0.50 fl. [13

Sudan Government: Agricultural Research Service. Report of the Government Chemist for the Year 1936. (Chemical Section, Publication No. 79.) Pp. 17. (Khartoum: Agricultural Research Service.) [13

Latvijas Valsts Meteorologiskais Birojs (State Meteorological Bureau of Latvia). No. 3: Pēdējo divu 30 gadu periodu (1871–1900 un 1901–1930) vidējo gaisa temperatūru salidzinājums (Mean Air Temperature Differences between last two 30 Year Periods). By J. Barloti. Pp. 14. No. 4: Gaisa temperatūra Latvijā (Air Temperature in Latvia). Dala (Part) 1: Gaisa vidējā temperatūra (Mean Air Temperature). By J. Barloti. Pp. 82. III: Meteorologisko novērojumu Gadagrāmata (Meteorological Observations Year Book) 1933. Pp. 48. (Rigā: Latvijas Valsts Meteorologiskais Birojs.) [13

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 69: Observations on some Wool Samples from North-Eastern Asia. By H. Munz. Pp. 28+8 plates. (Melbourne: Government Printer.) [16

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert, Mission G. F. De Witte (1933–1935). Fascicule 1: Introduction. Par G. F. De Witte. Pp. 39+32 plates. Les Parcs Nationaux et la Protection de la Nature. Pp. 88. Aspects de la végétation des Parcs Nationaux du Congo Belge. Serie 1: Parc National Albert. Vol. 1, Fascicules 1–2: Aperçu général de la végétation. Par W. Robyns. Pp. 42+12 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge.) [16

City of Durban. Jubilee of the Durban Museum, 1887–1937. Pp. 39. (Durban: Durban Museum.) [16

Archivos da Fundacao Gaffrée e Guinle, 1936–1937. Pp. iii+223+13 plates. (Rio de Janeiro: Rodrigues e Cia.) [17

Catalogues, etc.

Dunns Seed Wheats, 1937. Pp. 32. (Salisbury: Dunns Farm Seeds, Ltd.)

Beck Spectroscopes and Spectrometers. Pp. 16. (London: R. and J. Beck, Ltd.)