SATURDAY, SEPTEMBER 9, 1933

No. 3332 Vol. 132

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Biochemistry and Biology

A QUIET revolution is taking place in biological thought. The age of faith is past. No longer is either mechanism or vitalism upheld with religious fervour ; no longer do we cling to the Victorian creed that all things are ordered mechanically, or to its counterpart, that organic events are ruled by some immaterial agency. As Sir Frederick Gowland Hopkins said in his presidential address at the Leicester meeting of the British Association, "It is characteristic of the present position and spirit of science that sounds of the long conflict between mechanists and vitalists are just now seldom heard".

This does not mean that either vitalism or mechanism has triumphed ; it means that the field of discussion has shifted. It is now generally recognised that science cannot give us ultimate truth. We can fit various hypotheses to Nature, and the mechanistic one has served, and continues to serve, a very useful practical purpose, in stimulating and guiding research. Vitalism, at least in its dualistic form, has been essentially a critical rather than a constructive doctrine, and its main service has been as a much needed corrective to mechanism. But we realise now that neither view has any claim to absolute truth. The controversy between mechanism and vitalism has come down from the misty heaven of faith to the solid earth of practice, and what we are nowadays interested in is not the question, "Is the mechanistic theory true ?", but the more practical one, "Is it adequate as a general biological method ?" In addition, we have now as an alternative to mechanism, not dualistic vitalism, but a modern doctrine which may be described as the holistic or organismal.

These questions of biological method have been discussed during the past week from two points of view at the British Association meeting, incidentally by Sir Frederick Gowland Hopkins in connexion with his brilliant exposition of the advance of biochemistry, and directly by Dr. James Gray in his address to Section D on "The Mechanical View of Life".

Sir Frederick Gowland Hopkins defines the aim of biochemistry to be the furnishing of "an adequate and acceptable description of molecular dynamics in living cells and tissues", and he shows that great strides have been made towards achieving this ideal. Thus the power which the living cell possesses of selecting from its environment just those substances which it requires for maintenance and growth appears to be susceptible of a purely chemical explanation. "It is, however, no vital act but the nature of its specific catalysts which determines what it effectively 'selects'." The action of hormones and vitamins, which are relatively simple substances with definite chemical properties, also appears in principle to be explicable in biochemical terms.

"It is an immediate task of biochemistry to explore the mechanisms of such activities. It must learn to describe in objective chemical terms precisely how and where such molecules as those of hormones and vitamins intrude into the chemical events of metabolism. It is indeed now beginning this task, which is by no means outside the scope of its methods".

It is not claimed, however, that all the activities of living systems are based upon chemical organisation alone. This organisation, in Sir Frederick's considered opinion, accounts for one striking characteristic of every living cell—its power to maintain dynamic individuality in a varying environment. But cells and organisms exhibit other powers—of growth, differentiation, reproduction—and "it is not illogical to believe that such attributes as these are based upon organisation at a level which is in some sense higher than the chemical level".

While, then, biochemistry has fully justified itself in its study of the molecular dynamics of cells and tissues, at the higher levels of organisation, other methods, other concepts, may be necessary. The way is here left open to some form of holism.

The objection has often been raised to the analytical or physiological method that it studies only the parts of the organism in isolation from the whole, and neglects, what is fundamentally important, the relations of the parts to the whole, their coordination or weaving together into one functional unity. Sir Frederick Gowland Hopkins does not accept this limitation as inherent in the method, and maintains, against Prof. J. S. Haldane, that a knowledge of the whole can be best acquired by a study of the parts. Physiology, he holds, is "entitled to claim that its studies of parts are consistently developing its grasp of the wholes it desires to describe, however remote that grasp may be from finality". Analysis by itself is admittedly not enough, but it can be followed by intellectual synthesis, which will give us a fuller and more adequate conception of the activities of the organism as a whole.

Dr. Gray, in his address, maintained, and with full justification, that "the conception of the organism as a single living entity is, or should be, the more peculiar attribute of experimental zoology". While the biochemist and the physiologist study parts, the biologist studies (or should study) wholes. Thus the physiologist may properly investigate the properties of the sartorius muscle of the frog, in isolation from the rest of the frog's activities; what the zoologist is interested in is how the frog jumps, and how its sartorius acts in relation to its method of locomotion. (One might of course go a step further, and suggest that what is really of interest to the zoologist is not so much the method of locomotion as the behaviour of the frog—in what circumstances, and why, the frog jumps.) But the experimental zoologist finds it easier to start with what looks like the simpler problem, the functions of the isolated parts, and in practice he tends to make common cause with the physiologist and discuss vital activities in terms of cell-functions, and ultimately in terms of the physico-chemical properties of living matter. This leads, as Dr. Gray pointed out, to an over-simplification of the problem.

We have no right to assume beforehand that we can express all the properties of the organism in terms of physical and chemical laws, and if we look at the facts squarely we find little apparent justification for such a belief. For example, the spontaneous origin of living systems from inanimate matter, which is a matter of faith with the mechanist, is an event so highly improbable from the physical point of view that no physicist or chemist would be justified in considering its possibility seriously. For the differentiation of structure and function which takes place in development no physical explanation seems to be possible, and we are forced to postulate the possession by living matter of intrinsic properties or potentialities which are as fundamental and mysterious as the intrinsic properties of a radioactive molecule.

We may, if we like, think of a developing egg cell as a highly complex dynamical system which is physically unstable—"but where in the chemical world do we find such unstable systems acting in such a way as to build up and not to break down a highly complex structure?"

It seems, then, that we must accept, at least provisionally, in addition to the physical and chemical properties which they undoubtedly possess, the existence in living systems of intrinsic properties or potentialities, which are without parallel in the inanimate realm. In Dr. Gray's view, we must accept these potentialities as given or axiomatic, certainly at present.

Comparing the views of Sir Frederick Gowland Hopkins and Dr. Gray, we see that while the former holds that there may be levels of organisation where physical and chemical concepts are inadequate, the latter is convinced that this is definitely so, at least in the present state of our knowledge. Both agree that an understanding of the organism as a whole is the essential aim of biology; both reject dogmatic materialism.

This brings us back to our starting point. There is nowadays no room for dogmatism about the nature and origin of life. The real problem is simply one of method. Is it sufficient to treat the living organism as a complex physico-chemical system, and direct all our energies towards a closer analysis of it—to a study of its parts, regarded as chemical mechanisms—or must we recognise that it has properties and potentialities as a whole, and at certain levels of organisation, which are not reducible to the properties shown at the chemical level? The second alternative is that proposed in the organismal theory, and it seems to receive strong support from the arguments put forward by Dr. Gray, while it is not in conflict with the position taken up by Sir Frederick Gowland Hopkins.

This view accepts as fundamental the obvious fact that the living thing is a unity. It maintains that the organism as a whole manifests activities which are not mere summations of the activities of the parts, and accordingly that the whole cannot be satisfactorily reconstituted from the parts. The biologist, if he accepts the organismal view, cannot rest content with physico-chemical studies of the parts of the organism, which are the proper concern of the physiologist and the biochemist, but must study also and before all, the activities of the organism as a whole, in behaviour, development, reproduction and so on. He is at full liberty to use the general method of analysis, in order to deepen his knowledge of the parts in relation to the whole, but he must work down from the whole to the parts, rather than upwards from the parts to the whole. This is, as we conceive it, the proper method for biology to pursue.

Makers of Science

Great Men of Science: a History of Scientific Progress. By Philipp Lenard. Translated from the second German edition by Dr. H. Stafford Hatfield. Pp. xix+389+48 plates. (London: G. Bell and Sons, Ltd., 1933.) 12*s*. 6*d*. net.

AMONG scientific men, the degree of interest in the history of their subject varies curiously with age. As a rule, the young investigator has little interest in the origins of the scientific conceptions with which he works; it is only later when he has gained some personal experience of the ways in which new knowledge is secured, and the way in which the new developments are linked with the past, that he begins to take an interest in the history of his science and the achievements and personalities of the great pioneers.

In order to form a just idea of the relative importance of the work of different scientific men, it is essential not only to estimate the intrinsic value of their individual achievements, but also to take into account the prevalent ideas and the state of laboratory technique in their science in the period under consideration. We should thus expect to get a more balanced estimate of the achievements of scientific pioneers from one who is familiar at first hand with the scientific method, and has himself contributed to new knowledge, rather than from the professional historian however competent he may be in his own domain.

For these reasons, I have read with much interest and curiosity the book entitled "Great Men of Science" written by Prof. Philipp Lenard, for many years professor of physics in the University of Heidelberg, so well known to all physicists as a scientific investigator of great originality and power. The great men he has selected are in his own words those "who have brought forward something entirely new, having an essential bearing on our knowledge of nature, on our view of the universe and the position of man in nature". He begins with a brief account of the work of Pythagoras, Euclid and Archimedes and ends with Boltzmann, Hertz and Hasenöhrl. No man alive at the end of the War is included, except Crookes and Van der Waals, whose work was essentially complete before that period.

This is a book of very unusual character; in nearly every case the man himself as well as his scientific discoveries is brought vividly before the reader's mind. Lenard is interested not only in showing what new knowledge the men contributed but also in showing that their personal greatness matched their scientific achievements. The lives in most cases are brief, but always the nature of the advance in knowledge is brought out while the analysis is often most illuminating. Lenard considers the man and his work in relation to the state of knowledge at that time, and shows exactly the nature of his contribution.

The amount of space given to the lives varies from half a page or so for the older investigators about whom little is known to 17 on Faraday and 28 on Newton, with an average length of 5 or 6 pages. In a number of cases, a group of men are dealt with together, for example, Scheele, Priestley and Cavendish; Galvani and Volta, Davy and Berzelius; Mayer, Joule and Helmholtz; Hittorf and Crookes. This method has definite advantages both for comparison and brevity. All his great men are known for their contributions to physics and chemistry, except Darwin, Linnæus and Mendel. It may be that in some cases Lenard's judgment is contrary to accepted opinion, but if this is so it is the result not of personal prejudice but of a very close study of the subject. In fact, the whole book is singularly free from all trace of that scientific nationalism which is occasionally manifest in scientific writings to-day. In his preface Lenard tells us that in order to form a just opinion he read carefully not only historical works on science but also the actual publications of the men themselves. He makes the penetrating remark:

> "This study of the works of great investigators taught me that they had frequently achieved much more than they were usually given credit for. The richer the contents of their work, the more of it appeared to have been forgotten in course of time by the writers of histories and text books; or rather, the credit tended to be given to others who had later turned their attention to the subject and enlarged upon it when it was no longer new."

Throughout this book, there is manifest the joy of Lenard in scientific discovery, his love of scientific truth and his admiration for an upright man. No one can read his appreciation of the work of Newton and Faraday, for example, without feeling his admiration and almost veneration for their achievements and character.

Lenard's ideal of the man of science is the practice of straightforward scientific thinking in direct contact with Nature. He has little sympathy with the glorification of purely technical achievement, whether by experiment or calculation, but he delights in any ideas which give a simpler or a new insight into natural phenomena. He does not hesitate to express his disapproval of certain aspects of scientific activities of to-day, for example, the teaching of science in the schools and universities, and deprecates a materialistic outlook in science. He considers that the importance of mathematics in scientific discovery is generally overrated, although he fully recognises its value in working out the consequences of simple ideas in complicated cases. He emphasises that the quantitative relation involved in many of the greatest discoveries are of the simplest possible character not involving more than an elementary knowledge of mathematics. There are naturally many different shades of opinion on such a controversial subject, but I think it is generally recognised to-day that advance in science is most rapid and definite when the experimenter and the mathematical theorist work in close contact.

In the discussion of the life and work of his pioneers interesting remarks are often interposed, many of which, if space allowed, might well be quoted. In referring to the relations between the Royal Society and Newton, he makes the statement:

> "We thus again see quite clearly that great advances only come from single personalities and not from Societies, no matter how excellent the persons may in general be of which they are composed. Such Societies should therefore see their province exclusively in protecting and forwarding the work of the single and all too rare individuals who show themselves to be bringers of progress in any direction."

Few will question the accuracy of this view, which expresses in general the working ideal of our Royal Society to-day.

Excellent portraits are included of the great majority of his pioneers, and these form a background for an account of their lives and personalities which are in general brief and to the point.

This translation from the second German edition has been well carried out by Dr. H. Stafford Hatfield. A well-considered preface has been added by Prof. E. N. da C. Andrade, himself an old pupil and admirer of Lenard and his work.

This book is undoubtedly a remarkable achievement and is in itself a valuable original contribution to science. The reader who is interested in science will unwillingly skip a single page of this fascinating story of the work of great men, and many will wish to re-read parts again and again.

We warmly congratulate Prof. Lenard on his achievement in giving us such a masterly presentation of many of the great men of the past. His book should be read by everyone interested in science whether as a teacher or investigator, and I am sure it will lead to an even greater appreciation of the singleness of purpose and of the high ideals of those great men who laid the foundation of our sciences. RUTHERFORD.

Submarine Biology

Nonsuch : Land of Water. By Dr. William Beebe. Published under the auspices of the New York Zoological Society. Pp. xv+245+47 plates. (London and New York : G. P. Putnam's Sons, Ltd., 1932.) 21*s.* net.

TIME was when men dreamed of competing with the birds in mid-air, but in more sober moments the realisation of this dream was regarded as a forlorn hope. To-day it is an accomplished fact; and now fresh fields to conquer are being explored 'fathoms deep' beneath the sea.

This conquest was begun by the diver, for purely utilitarian ends, but Dr. William Beebe, director of the Department of Tropical Research of the New York Zoological Society, some years ago began devising methods whereby the living animals of the sea might be studied at close quarters, as we study birds and beasts. The astonishing success which has attended his efforts are well known, and marine zoologists are under no misapprehension as to the debt they owe him. For it is well enough to glean from the harvest of the sea by means of nets, but even better to go down in place of the net, and study the ways of the creatures of the deep as they live, and move, and have their being. This Dr. Beebe has contrived to do: and as yet he stands almost alone in this new mode of research, carried on, sometimes, at a depth of eight fathoms.

Some of Dr. Beebe's achievements are recorded in the volume now before us, wherein he gives us a vivid and most valuable account of his work around Nonsuch Island, one of the Bermudas, and from which his book derives its title. One instance of the strange things this volume contains must suffice. Dr. Beebe had been lowered to a depth of eight fathoms, and landed on a mass of coral. Pieces kicked off this soon brought crowds of hungry fishes to the spot. "If I derived any satisfaction from being a freak pioneer, I could boast that I was the first human being who had fed fishes by dancing on coral-tops eight fathoms down. The fish were considerably larger than those of the inshore reefs: blue surgeons and angel-fish, giant butterflies, parrots over four feet. . . . Now and then I see a fish new to our list, or even to Bermuda."

One is left wishing that Dr. Beebe had given us rather more of his work in this underworld; but not at the expense of his most interesting survey of the animal life of the rock-pools and shore, and of the birds of the island, for these all have a bearing, more or less direct, on the life of the deeper waters.

The Mistress to the Theoric

Anschauliche Geometrie. Von D. Hilbert und S. Cohn-Vossen. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, herausgegeben von R. Courant, Band 37.) Pp. viii+310. (Berlin: Julius Springer, 1932.) 25.80 gold marks.

A FOUR-HOUR lecture by Prof. Hilbert has been expanded by Dr. Cohn-Vossen, in a pleasant style perfectly suited to the subject, into surely the most fascinating volume ever offered to the ordinary mathematician. Consider the main topics: thread constructions and linkages; lattices, with applications in two dimensions to the theory of numbers and in three dimensions to crystallography; the simpler configurations, including the double-six; the elements of differential geometry, with an account of the elliptic and hyperbolic planes; and lastly, topology, with a long section on one-sided surfaces, and a proof of the fundamental fixed-point theorem in the theory of continuous transformations, as well as an exact statement of the difficulties in the familiar four-colour problem.

The scope may be indicated by reference to a long section entitled "Eleven Properties of the Sphere", where under the heading "The sphere has no focal surface" we find an account of Dupin's cyclides, introduced as the surfaces for which the focal surfaces degenerate to curves; under the heading "All the geodesics on a sphere are closed curves" we learn why a motor-car must have a differential; and under the heading "The sphere has constant positive Gaussian curvature" we are told that a closed convex surface is absolutely rigid if it is indeformable.

Over-educated, we are prone to look with suspicion on expositions of this kind. Of all names in the world, perhaps Prof. Hilbert's gives the best guarantee that the eye is not to be allowed to deceive the mind. Moreover, we are reminded again and again that analysis must supply a proof in cases where intuition makes a result only plausible, and sometimes we are warned that the investigation is difficult, but it is the range rather than the limitations of intuitional methods that will be a revelation to many readers.

The book is amply illustrated, partly by photographs, and partly by most careful and vivid diagrams, for the sake of which it should be in the draughtsman's office of every firm which has textbooks or treatises on geometry to produce.

The firm of Springer, which has for many years been very active on the board of mathematical publications, is to be congratulated on the success of a move which is appropriately not along one of the direct lines. If I deplore the price of the volume, it is not with any suggestion that it is excessive but only out of regret that it puts the work beyond the reach of hundreds of mathematical students and teachers to whom it would be an inspiration and a delight. E. H. N.

Jurassic Rocks of Britain

The Jurassic System in Great Britain. By Dr. W. J. Arkell. Pp. xii + 681 + 42 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1933.) 30*s*. net.

NEARLY forty years have elapsed since the publication of the Geological Survey monographs on the Jurassic rocks of Britain. In the interval, much research on these formations has been carried out by a small band of enthusiastic workers, prominent amongst whom was the late S. S. Buckman; and the absence of a volume co-ordinating the results of their studies has been viewed almost with reproach, since the sections in England are virtually the standards of comparison for the world. Few workers, however, have had time or experience to tackle what had become a formidable task. Fortunately, for the honour of British geology, Dr. Arkell has stepped forward. With youth in his favour, leisure enough to concentrate the whole of his energies to the work and thereby rapidly gain a wide experience of the formations in the field; an outstanding capacity to digest the literature, combined with the possession of a logical mind and a rare facility in the art of expressing the salient facts in crisp, lucid English, he has written a book which places every student of the Jurassic rocks, British and foreign alike, under a deep debt of gratitude to him. The volume will rank for many a year to come as the most authoritative account of these formations in Britain, and the success which has attended his efforts raises the hope that other authors will follow his lead and produce similar volumes on the other geological systems in Great Britain.

The book is divided into four parts. In the first is given a clear exposition of the principles underlying the various schemes of classification which have come into use since the days of William Smith. In this the author has much to say in regard to the work of S. S. Buckman. Generally, Dr. Arkell is judiciously impartial, praising the early constructive work of this great British palæontologist, but roundly chastising him for the errors he perpetrated in his later studies, particularly those to be found in the last few parts of "Type Ammonites". Emphasis is thus laid on the fact that palæontological studies divorced from field-work are likely to prove worthless and misleading.

In the two succeeding parts the general structure of the basins of deposition, the contemporaneous tectonics and their effects on sedimentation, and the formations themselves, are ably discussed. The author has added much to the value of the stratigraphical chapters by submitting them before publication to various competent geologists for criticism, and as a result each chapter may be said to carry the seal of authority. In the concluding part the information given respecting the distribution of corals and ammonites contains much that is new, and in the section dealing with the general boundaries of the Jurassic troughs, Dr. Arkell discusses the various views put forward in a characteristically illuminating manner.

The book is enriched by many illustrations, and a number of plates at the end are devoted to fossils of zonal value. Merely to mention that many of the photographs are the work of Mr. J. W. Tutcher is sufficient to testify to their high degree of excellence. There is a useful appendix giving a list of 120 stage names hitherto proposed, and an extensive bibliography. J. P.

Short Reviews

Applied X-Rays. By Prof. George L. Clark. (International Series in Physics.) Second edition. Pp. xiv+470. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1932.) 30*s*. net.

"This science, it keeps going on," remarked one of the more plebeian of Mr. Wells's galaxy of characters. The thought is platitudinous, but it is inevitable when one compares the drawing of the primitive cathode ray tube used by Röntgen with that of, say, the Hadding-Siegbahn tube used in crystal analysis, or the Siemens-Pantix deep-therapy tube operating at 400 kv. and 5 ma. We read now of high voltage tubes that have been constructed to operate at 2,600,000 volts, in which electrons are so speeded that they drill holes an inch deep in a brass plate. An almost incredible advance since that winter's day, but a little more than a generation ago, when Schuster, calling at his laboratory for his letters, forgot his family and his dinner in the fascination of reading a paper, just received by post, on "Eine neue Art von Strahlen".

Dr. Clark chronicles these advances clearly and succinctly. His book, as its title implies, is concerned primarily with the practical side and, of the two parts into which it is divided, the first and shorter part is concerned with the details of tubes and equipment, spectra, chemical analysis, absorption and scattering, radiography and chemical, physical and biological effects. In the second part, nearly 300 pages are devoted to the X-ray analysis of the ultimate structures of materials.

In the second edition the book has been almost entirely recast and forms an admirable manual of the subject of X-rays on the applied side. A. F.

A Psychologist's Point of View: Twelve Semi-popular Addresses on various Subjects. By Charles S. Myers. Pp. vii+207. (London: William Heinemann (Medical Books), Ltd., 1933.) 7*s*. 6*d*. net.

This is a collection of semi-popular papers on a dozen diverse subjects, all treated from the point of view of a psychologist. The name of Dr. C. S. Myers, principal of the National Institute of Industrial Psychology, is of itself a guarantee that the truly scientific attitude is maintained throughout. A good example is the paper on Freudian psychology, which combines candid and searching criticism with just appreciation of a distinguished man's contribution to the subject. Three of the papers deal with important points in industrial psychology. A particularly helpful paper is the one in which the true relation between instinct and intelligence is unfolded. There are few psychologists, if any, who have done so much as Dr. Myers for the application of psychological principles to practical problems of life; and this book well exemplifies the spirit and method of his work.

Atomic Energy States: as Derived from the Analyses of Optical Spectra. Compiled by Dr. Robert F. Bacher and Prof. Samuel Goudsmit. (International Series in Physics.) Pp. xiii+562. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1932.) 36*s*. net.

An important and interesting compilation, intended to give numerical values of energy levels of atoms and ions investigated up to "the present". The authors believe that the record is complete up to the spring of 1931, and include, moreover, much unpublished material concerning work later than this date. The volume is almost entirely in tabular form, an introduction of 21 pages being followed by about 520 pages of tables in which the classifications and term values are arranged in alphabetical order of the emitters from A I to Zr IV.

The book is critical, and will form a most valuable addition to the working library of the spectroscopist.

Optik: ein Lehrbuch der elektromagnetischen Lichttheorie. Von Prof. Dr. Max Born. Pp. vii+591. (Berlin: Julius Springer, 1933.) 38 gold marks.

The sub-title of this scholarly volume indicates the direction of approach to the subject taken by the author. It must be noted, also, that the work contains a concise but valuable section of some sixty pages dealing with the fundamental problems of geometrical optics. The author then proceeds to develop his subject by successive chapters on interference, diffraction, crystal- and metal-optics, and molecular optics, concluding with a very full treatment of emission, absorption and dispersion.

No more need be said of the book than that it is worthy of the reputation of Prof. Born. There are a number of errors which demand correction, and the publishers have recently put out a "Berichtigungszettel", which will, presumably, be supplied with all copies of the work now placed on the market. A. F.

Treatise on Sedimentation. Prepared under the Auspices of the Committee on Sedimentation, Division of Geology and Geography, National Research Council of the National Academy of Sciences. By William H. Twenhofel and collaborators. Second edition, completely revised. Pp. xxix+926. (London: Baillière, Tindall and Cox, 1932.) 46*s*.

The second edition of this treatise has been revised and very considerably enlarged, and the number of illustrations increased. The revision incorporates information resulting from an extensive search of extra-American literature. In this respect an attempt has been made to remedy the deficiencies of the previous edition (see Nature, 120, 327, Sept. 3, 1927). As it stands, the work constitutes a mine of information on sedimentary rocks and the processes of sedimentation.

Extremely Low Temperatures

By PROF. W. J. DE HAAS, University of Leyden

IN 1926 Debye pointed out that temperature must decrease when a magnetised body is demagnetised adiabatically. Giauque made the same remark in 1927; and still earlier the same idea was expressed by Langevin for oxygen. Debye calculated the predicted effect for the case of gadolinium sulphate. His calculation was based upon the following considerations: a magnetisable body contains a great number of small elementary magnets. When such a body is magnetised these magnets are directed. The part of the entropy belonging to this order is decreased and, the process being supposed isentropic, the part of the entropy connected with the statistical movement must necessarily increase. When, on the contrary, the disorder of the elementary magnets is increased by demagnetisation, the part of the entropy connected with the magnetisation is increased and the part belonging to the statistical movement is decreased, so that the body is cooled down.

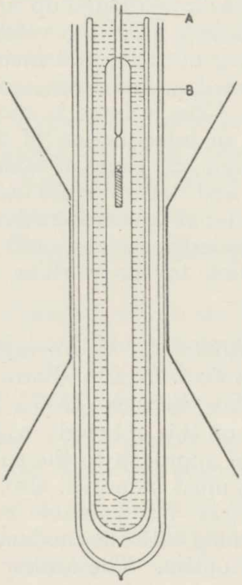

FIG. 1.

If we wish to obtain easily seen results, the following points require special attention: (1) the elementary magnets shall not exert a directing influence upon each other (no ferromagnetic body); (2) the elementary magnets shall have a moment as large as possible, subject to the restriction of (1); (3) at low temperatures the effect will be greatest, as here the part of the entropy belonging to the magnetisation becomes comparable with the other part, while at the same time the order strongly increases.

The condition to be fulfilled by the experimental arrangement in order to obtain extremely low temperatures is that the exchange of heat with the surroundings both by radiation and by connexion is cut down. In our experiments this condition is satisfied. The substance that is cooled down is at the same time used as a thermometer.

The experiments were made with cerous fluoride (a weakly paramagnetic salt of one of the rare earths) as suggested by Prof. Kramers, of Utrecht (see "Leipziger Vorträge", 1933). Fig. 1 very diagrammatically represents the experimental arrangement. The rod A is fixed to a balance. It carries a small Dewar flask, which contains a small tube filled with cerous fluoride and suspended by a central carrier B. The whole apparatus is placed between the poles of the large electro-magnet of the Kamerlingh Onnes Laboratory in such a way that the salt occupies the spot of maximum $H.dH/dx$ ($x =$ vertical co-ordinate). The lower extremity of the rod A together with the small Dewar flask is surrounded by liquid helium boiling at 1·26° K. The thermal insulation of the cerous fluoride is so good, that after 4–5 hours only a very small quantity of salt of exceedingly low heat capacity (the latter is inversely proportional to T^3) is cooled down to 1·26° K.

We know that finally this temperature has been reached, because the salt is the indicator of its own temperature. This paramagnetic body is drawn into the field (31 k. gauss) by a force $K=M.dH/dx$, where M is the total moment of the body. As $M = \varphi(H, T)$ and as H remains constant, we easily see, by measuring K, when T has become constant.

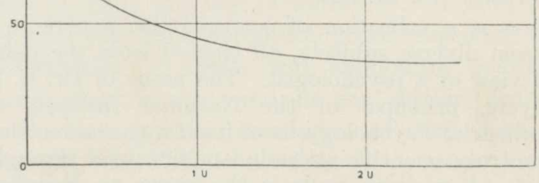

FIG. 2.

As soon as this is the case the body is demagnetised by lowering the field to 2·7 k. gauss in the first experiments, to 1,000 or 500 gauss in later experiments.

In this weak field the force K is measured as a function of the time. In this way we obtain a curve as shown in Fig. 2.

The point A on the curve corresponds to the force at the lowest temperature, while the asymptote after a long time corresponds to the force at 1·26° *K*. The steep fall of the curve in the beginning is due to the fact that in the vacuum of the small Dewar flask a trace of helium (10^{-7} mm.) has been left intentionally for thermal contact. This helium gas is condensed under development of the heat of condensation. When the pressure of the helium gas is still lower, the curve has a different form and heating up with the time goes extremely slowly. The cold has been caught in a trap. The vacuum becomes practically absolute and heat is no longer transmitted.

The forces are directly proportional to the moments and the only thing we have to find out is to which temperatures these moments correspond. The connexion between temperature and moment has been determined between 7·2° *K*. and 1·3° *K*. The curve representing this connexion was extrapolated linearly, though this gives a stronger increase of the moment than the curve itself does. That is why we can only give an upper limit of the temperature reached.

The first experiments were made in March and April of this year with cerium fluoride and gave as the upper temperature limit 0·27° *K*. More recent experiments with dysprosium ethyl sulphate gave the upper limit 0·17° *K*. Finally, the experiments of July last made with cerium ethyl sulphate gave as the upper temperature limit 0·085° *K*.

It is possible that with the same experimental arrangement much lower temperatures can be reached. The choice of the right substance will decide further results. I am convinced that with the above-described arrangement the theoretical limit can be reached.

Up to the present, the lowest temperatures had been reached with the aid of liquid helium, boiling under very low pressures. The results of this method evidently depend upon the capacity of the pumps used and upon the perfection of the thermal insulation.

With this method Kamerlingh Onnes reached in October, 1921, a temperature of 0·82° *K*. Keesom worked with diffusion pumps of a capacity fifteen times higher than that of the pumps Kamerlingh Onnes had. In 1929 he reached a temperature of 0·71° *K*. It is, however, difficult to proceed much further in this way.

The conception of temperature is based upon the properties of the ideal gas. The temperature is determined with the aid of the helium thermometer (several corrections being applied). At the extremely low temperatures reached recently no gas thermometric measurement of the temperature is possible, so far as I can see.

A thermometric scale based upon another process must be fitted to the absolute temperature scale ; only a magnetic scale can be used for this purpose.

Just as was done in gas thermometry, we shall have to find some substances, which within a considerable range of temperature show the same behaviour; a highly developed theory will then enable us to fix the temperature with the same accuracy by means of magnetic thermometry as by the use of gas thermometric methods.

A reservation must be made, however, for the case that at very low temperatures the substances used might become ferro-magnetic or might show a new kind of ferro-magnetism. In this case little might be said about the temperature.

Another great difficulty is this : if by means of the magnetic method we wish to cool down other substances, the question of the thermal contact becomes urgent. The radiation is negligible, and also the vapour pressure of the helium becomes so small that thermal contact by means of gaseous helium can scarcely be considered.

The experiments were made in collaboration with Dr. E. C. Wiersma, conservator of the Laboratory, to whom I express my warmest thanks for his help and for many suggestions. To Prof. H. A. Kramers of Utrecht I am indebted for his valuable theoretical assistance.

Intermediate Products and the Last Stages of Carbohydrate Breakdown in the Metabolism of Muscle and in Alcoholic Fermentation*

By Dr. Otto Meyerhof

From these new results we see that the assumption of the rôle of methylglyoxal as an intermediate product in the splitting of carbohydrates becomes superfluous. Upon the discovery of methylglyoxalase by Dakin and Neuberg, the whole biochemical world was seized with the idea that lactic acid formation must take place with methylglyoxal as an intermediate. This was also applied to the formation of pyruvic acid during alcoholic fermentation.

In the meantime, in our own laboratory the 'stock' of methylglyoxal had sunk to a low level. Lohmann's discovery of the part played by glutathione as the co-ferment of methylglyoxalase sent them down to rock bottom. In addition to the many important functions in the biochemistry of the cell which have been ascribed to Hopkins' glutathione, Lohmann has added a new one of great interest, namely, that glutathione acts as a true co-enzyme of methylglyoxalase. Now, after adding adenylpyrophosphoric acid and magnesium ion, glycogen was easily transformed into lactic acid in muscle extracts from which the glutathione had been dialysed away so that they could not convert methylglyoxal. It was also observed in new experiments that, with the same conditions, but in the presence of sulphite, pyruvic acid is formed, although, even in the presence of glutathione only traces of pyruvic acid are formed from

* Continued from p. 340.

methylglyoxal. We now recognise the formation of lactic acid as a true oxidation-reduction process in which the previous puzzling rôles of pyruvic acid as well as that of the esterification of the hexoses receive a new significance.

This observation is important also in deciding the question as to exactly where the two processes of alcoholic fermentation and lactic acid formation leave their common path. This question has occupied me for the past three months. Neuberg has assumed pyruvic acid as an intermediate in his well-known fermentation scheme, basing his hypothesis upon the discovery of carboxylase. Although this part of the scheme is now to be regarded as proven, one must also here remove the erroneous assumption that the pyruvic acid is derived from methylglyoxal. Neuberg himself had in the meantime shown for dry yeast, exactly as Embden had for muscle tissue, that phosphoglyceric acid can be transformed into pyruvic acid. It follows then, as can readily be shown, that in fresh yeast extract phosphoglyceric acid would be briskly decomposed into acetaldehyde and carbon dioxide. On the other hand, Nilsson had isolated, so early as 1930, phosphoglyceric acid from dry yeast in the presence of fluoride, hexose di-phosphate, and acetaldehyde.

In maceration juice containing fluoride, exactly in the same manner as in muscle extract, hexose di-phosphoric acid is actually converted into Lohmann's 'unhydrolysable ester', consisting of equimolecular portions of glycero-phosphoric acid and phosphoglyceric acid. The phosphoglyceric acid, added to fresh yeast extract, decomposes, as shown, into carbon dioxide, phosphoric acid and acetaldehyde. However, α-glycero-phosphoric acid does not react further and, since added sugar or hexose di-phosphoric acid is completely fermented by yeast, this stable compound cannot be formed during fermentation. The reduction of the aldehyde, therefore, is not accomplished by the glycero-phosphoric acid, but in another manner. Nilsson in Euler's institute had already come across this reaction, but he failed to recognise its importance. Apart from the presence of carboxylase, this peculiar reaction is the principal difference between alcoholic fermentation and lactic acid production.

Nilsson established that when fluoride, glucose, hexose di-phosphate, and acetaldehyde are added simultaneously to dry yeast, with no fermentation taking place whatsoever, aldehyde is reduced to alcohol and sugar is simultaneously esterified. He identified the resulting ester as probably being phospho-glyceric acid. His observation was correct. I have followed the reaction further quantitatively and found two noteworthy fermentation equations.

When we add only hexose di-phosphoric acid to fluoride containing maceration juice, the ester is slowly converted into phosphoglyceric acid and glycero-phosphoric acid, at the same rate at which it is fermented in the absence of fluoride. If glucose alone, instead of hexose di-phosphoric acid, be added to maceration juice containing fluoride, no esterification takes place; for as I had observed earlier, glucose alone in the presence of fluoride is not esterified. It is different, however, when glucose and hexose di-phosphate are added simultaneously. In this case, glucose is esterified, but only to a certain extent. The reaction stops when a quantity equimolecular to the hexose di-phosphate has been esterified. The reaction is rapid, proceeding again with the same velocity as sugar fermentation in the absence of fluoride. Also this reaction produces a mixture of esters, consisting of almost equal quantities of glycero-phosphoric acid and phosphoglyceric acid. This is shown in equation A in Table 2.

TABLE 2. New fermentation equations (with sodium fluoride).

A.	1 Hexose di-phosphoric acid + 1 Glucose + 2 Phosphoric acid	=	2 α-Glycero-phosphoric acid + 2 Phosphoglyceric acid
B.	2 Acetaldehyde + 1 Glucose + 2 Phosphoric acid	= ↑ (Hexose di-phosphoric acid)	2 Alcohol + 2 Phosphoglyceric acid

Addition of acetaldehyde changes this system altogether. The reaction proceeds further, aldehyde becomes alcohol and sugar is simultaneously esterified, but all the glucose that enters into the reaction is now converted into phosphoglyceric acid. Glycero-phosphoric acid appears only to the extent that hexose di-phosphate is decomposed. The esterification and oxidation of the glucose proceeds until all the aldehyde has been converted into alcohol. As in this case the extent of the reaction depends not upon the quantity of hexose di-phosphate, but upon the amount of acetaldehyde added, the concentration of the hexose di-phosphate can be reduced to a large degree and yet accomplish the conversion of the sugar until the reaction is stopped by exhaustion of the aldehyde supply. In this manner an extremely small quantity of hexose di-phosphate, less than a tenth of a milligram per cubic centimetre of fermentation mixture, can lead to the esterification of fifty or a hundred times as much glucose. If one uses only a trace of hexose di-phosphate, then equation B in Table 2 is exactly satisfied. Here the hexose di-phosphate does not enter into the equation. It acts like a true catalyst. Actually, in the presence of acetaldehyde, hexose di-phosphate added in excess does not enter into the reaction, taking no part whatsoever in the course of reaction B. The velocity of reaction B is exactly as great as the maximum fermentation velocity of sugar. The necessary quantity of hexose di-phosphate is not larger than that which I found necessary fifteen years ago to initiate the fermentation, that is, to abolish the induction period, in maceration juice.

To explain further these peculiar intermediate reactions, I should like to add two more points.

(1) In place of hexose di-phosphoric acid, glyceric aldehyde phosphoric acid can be used. It behaves in both equation A and equation B practically the same as hexose di-phosphate. If it be assumed that

only *one* optical antipode enters into reaction, then the quantities of organic phosphorus necessary to accomplish the same amount of esterification are approximately the same. Thereby, the velocity of the rearrangement of the glyceric aldehyde phosphoric acid is greater than that of hexose di-phosphoric acid, while on the other hand the system glucose plus hexose di-phosphate reacts somewhat more rapidly than the system glucose plus glyceric aldehyde phosphoric acid. The glyceric aldehyde phosphoric acid can also be used to abolish the induction period. There is thus nothing to contradict the supposition that glyceric aldehyde phosphoric acid is formed as an intermediate product.

(2) The rôle of the acetaldehyde in the progress of the esterification consists in the oxidation of the momentary reaction products. One can therefore replace the acetaldehyde fairly well with other reducible systems, for example, methylene blue. Thus, the esterification can be conducted in accordance with equation B, using methylene blue instead of acetaldehyde. In this case, the oxidation product seems to be also phosphoglyceric acid. Therefore, methylene blue can also be used similarly to acetaldehyde as an activator of fermentation. The aldehyde reacts obviously with a nascent triose phosphoric acid produced from the reaction between glucose and hexose di-phosphate. At the same time the aldehyde prevents the rearrangement of the triose phosphoric acid into glycero-phosphoric acid, so that the entire triose phosphoric acid is oxidised to phosphoglyceric acid. Everything gathered together results in the fermentation scheme shown in Table 3.

Here, in accordance with data obtained from kinetic studies it is necessary to separate the initial period of fermentation from the stationary state. In this case also, fluoride alone inhibits reaction B, while iodoacetic acid does not inhibit B, but does inhibit reactions A and C.

TABLE 3. New fermentation scheme.

INITIAL PHASE					
A.	1 Hesose di-phosphoric acid + 1 Glucose + 2 Phosphoric acid	=	4 Triose phosphoric acid	=	2 α–Glycero-phosphoric acid + 2 Phosphoglyceric acid
B.	2 Phosphoglyceric acid	=	2 Pyruvic acid + 2 Phosphoric acid	=	2 Acetaldehyde + 2 Carbon dioxide + 2 Phosphoric acid
STATIONARY CONDITION					
C.	2 Acetaldehyde + 1 Glucose + 2 Phosphoric acid	=	2 Triose phosphoric acid + 2 Acetaldehyde	=	2 Alcohol + 2 Phosphoglyceric acid

This new scheme will be seen to agree with all known facts. It explains the esterification of the phosphates, the characteristic catalytic rôle of the hexose di-phosphoric acid and the part played by acetaldehyde in determining the initial period. It shows fermentation further as an oxidation-reduction process in which most probably the dismutation of two aldehydes, acetaldehyde and glyceric aldehyde phosphoric acid, play the crucial parts. Finally, it brings the carboxylase into the process in an easily conceivable manner. The difference between alcoholic fermentation and lactic acid formation is to be found in the fate of the pyruvic acid. While pyruvic acid in muscle extract is reduced to lactic acid by the glycero-phosphoric acid, in yeast, it is split up into carbon dioxide and acetaldehyde, which acetaldehyde is then reduced. This reduction, however, is not accomplished by the glycero-phosphoric acid, but by some precursor, probably the glyceric aldehyde phosphoric acid. This circumstance determines the peculiar disproportionality of the reaction chain and compels us to set up one equation for the initial period and another for the stationary condition. The periods of induction and rising fermentation are, as well known, not present in lactic acid formation.

The recognition of these facts, which are all more or less connected with the Embden scheme of lactic acid formation, has brought us a good step forward and I think that now a large number of previously known facts may be fitted into a unified picture.

The British Association at Leicester

ON the eve of a meeting of the British Association, the members about to converge on the chosen site begin to take a lively interest in its merits and demerits.

A booklet of a hundred pages entitled "A Scientific Survey of Leicester and District", prepared for the Leicester meeting, partly answers this and shows very clearly the inescapable advantages and disadvantages of position revealed in the accounts of the geology and climate ; the natural features that result in its flora and fauna ; and the development by man of its economic possibilities described under farming and under industries of Leicester. This association of factors and interlocking of cause and effect is well brought out by the editor of the booklet, Dr. P. W. Bryan, in his account of Leicester in its regional setting.

The corporate work of the citizen is described by the Town Clerk in a brief résumé of the rapid increase of activities since the establishment in 1835 of the new municipal body, particularly in relation to trading undertakings. Education, as a very special part of municipal responsibilities, is presented by the director of education, Mr. F. P. Armitage.

These accounts give prominence to the extreme administrative activity and forward thinking which resulted in the reorganising and in particular the re-grouping by 1929 of all the council schools in Leicester, in such a way as to make possible educational provision more closely related to individual need and capacity. What may be termed the welfare aspect has been developed *pari passu* by means of playing fields and by constant remedial help.

The section on men of science in Leicester and Leicestershire cannot fail to be of special interest to members of the British Association and its well-wishers, for it is by workers rather than by facilities—though these have become increasingly necessary for modern work—that science advances.

The late but timely appearance of the new "Flora of Leicestershire and Rutland" by A. R. Horwood and the late Lord Gainsborough (London: Oxford University Press, 35*s*. net) no doubt accounts for the omission from the section of some, more particularly concerned with this type of work, who would otherwise have found a place.

The flora now hot from the Press is indeed no mere flora but a massive compilation of information about the plants of the district, written to a large extent in the modern ecological and genetical spirit by Mr. Horwood, who was connected with Leicester and its museum for so many years. The introduction alone takes up some three hundred pages and includes not only accounts of the characteristic plant groupings of certain districts but also features of the topography, geology and agriculture.

In the "Scientific Survey" account of men of science connected with Leicester, many worthy names occur, but the most outstanding are those of Alfred Russel Wallace and Henry Walter Bates of Amazon fame. Born in the first quarter of the nineteenth century, within two years of one another, they early became fast friends. Bates, apprenticed to a hosier, found education and delight in Charnwood Forest, while Alfred Russel Wallace enlivened the tedium of the life of a schoolmaster by the enthusiastic cultivation of the study of botany with the establishment of a herbarium. Fired by Charles Darwin's "Journal of a Naturalist" they went to the Amazon together in 1848, and some years after there appeared Bates's "A Naturalist on the Amazon" and later, Wallace's Linnean contribution paralleling and indeed preceding Charles Darwin's theory of evolution. No greater thing has come out of Leicester.

Altogether the survey presents an interesting and stimulating account of the factors operating in and about Leicester and of the human response which makes it a continually improving city. Visitors will probably be interested in the *means* which have been taken to secure a good water supply, to dispose of its sewage in spite of the awkward basin shape of the site and to foster the welfare and education of its young citizens. The readers of the booklet, however, may wish that they had been supplied with more information concerning the development of university education and research in this region and all that has come with it during the last decade in the way of exposition and research in the sciences. The University College, in spite of many handicaps, has equipped and sent out students, some of whom were of the highest merit, able to take honourable positions in industry or the services, and it has fostered the spirit of research and been the *fons et origo* of many publications on pure science and its applications. During this period a record number of eminent scientific workers of rare lecturing capacity have been induced by the College to give freely of their best to Leicester. It is a sign of the trend of modern times and not unfitting in the city of Wallace and of Bates that a large proportion of these eminent investigators have been biologists.

Obituary

Dr. V. H. Veley, F.R.S.

DR. V. H. VELEY, who died on August 20, aged seventy-seven years, was my tutor from 1896 until 1900, and during term time I used to see him at least two evenings a week in his house in Norham Road, as well as working with him in the laboratory near the Parks about three mornings a week. At that time he had attained his fellowship of the Royal Society, and a considerable reputation, through his paper on the "Hydrate Theory of Solution", which was at the time the subject of controversy, and had been made the subject of partisan feeling by the followers of the ionic dissociation theory of solution which was advocated by Ostwald. We, as Dr. Veley's pupils, had naturally to read both sides of the question, and just as naturally, I think most of us had leanings towards the views of our tutor. In the laboratory, whereas it cannot be said that he was a driver for idle pupils who wished to do as little work as possible, there was no doubt if one did take an interest he was always ready to help one in difficulties, and he had a very clear style in explaining and teaching.

At one period during the time when I was up, there was a large quantity of Demerara rum shipped to Great Britain, which, when let down from 40° overproof to standard strength, developed what was known commercially as 'cloudiness and floaters'. In some cases this faultiness became almost like a sediment of frog spawn in the rum puncheons. Dr. Veley, jointly with his wife, investigated this, and they discovered a micro-organism which was named by him *Coleothrix Methystes* (from the Greek for 'drunkard', a rather happy suggestion of Mr. Arthur Sidgwick). It is a remarkable organism insomuch as it is capable of living in alcohol 40° overproof in an attenuated condition, and when dilution takes place it is able to increase at such an extraordinary pace that it produces 'faultiness'. Our tutor's investigations on this subject were of far greater interest to us, as pupils, than working for the 'schools'.

Outside his work, Dr. Veley was always a very delightful man to meet socially, and took an interest in all that went on in the College. At an earlier date he had coxed the University crew in May, 1877 (Head of the River), and to one who was so much interested in rowing as well as chemistry, it was a happy combination.

JOHN A. TINNE.

DR. VELEY'S vigorous and piquant personality impressed all who had the privilege of his friendship. He had a vivid memory, a deep fund of humour and dry wit. The acuteness of his mind and his power of swift observation—gifts which made him eminent in scientific inquiry—showed themselves in all his conversation. There was a kindly tartness in his talk, making his conversation memorably individual.

He felt strong affection for Rugby, and his memories of his old school found expression in speeches at meetings of former members of the school house. He was one of the most distinguished among his surviving contemporaries.

At Oxford Dr. Veley did work of great value both as an investigator and as a teacher. His intellectual force contributed to the growing influence of his department. A member of University College he was one of the body of men who, through their work in the laboratories and by the instruction of their pupils, strengthened year by year the position of science in Oxford.

His French ancestry meant much to him. There was a French quality in his mind. He remembered how much of him had its roots in Auvergne and in French Switzerland. His family were living at Yverdun in the earlier years of the nineteenth century and he recalled what he had heard members of an older generation say about Pestalozzi.

M. E. SADLER.

WE regret to announce the following deaths:

Prof. W. G. Craib, regius professor of botany in the University of Aberdeen, an authority on the flora of Siam, on September 2, aged fifty-one years.

Mr. A. H. Kidd, secretary of the University Grants Committee for the past eleven years, on August 27, aged forty-eight years.

Sir Philip Magnus, Bt., for many years superintendent and secretary of the Department of Technology of the City and Guilds of London Institute, on August 29, aged ninety years.

Major Robert Mitchell, C.B.E., vice-president of the Polytechnic, Regent Street, W.1, Director of Education at the Polytechnic in 1873–1922, on August 27, aged seventy-eight years.

News and Views

Physico-Chemical Mechanisms and Vital Properties

IN his presidential address to the British Association delivered at Leicester on September 6 and printed in the Supplement to this issue of NATURE, Sir Frederick Gowland Hopkins reviews, with a competence all his own, some of the recent triumphs of biochemistry. He shows with a wealth of apt illustration how important biochemical research has become, not only for the well-being of the human race, but also for the progress of biological thought. He rightly claims that "in passing from its earlier concern with dead biological products to its present concern with active processes within living organisms, biochemistry has become a true branch of progressive biology. It has opened up modes of thought about the physical basis of life which could scarcely be employed at all a generation ago. Such data and such modes of thought as it is now providing are pervasive, and must appear as aspects in all biological thought". No one, we imagine, will seriously dispute this claim. Great interest is attached to the President's references to the further question, so important for biology, "Can the living organism be adequately treated as a physico-chemical system?" To this question a cautious answer is given. He claims only that on the chemical level the activities of the organism can be fully interpreted in physico-chemical terms alone, and he adds that there are other and higher levels of organisation where it is by no means certain that physico-chemical concepts will suffice.

THE same question was discussed by Dr. James Gray in his presidential address to Section D (Zoology) on "The Mechanical View of Life". Dr. Gray regards it from the point of view of the experimental zoologist, which is not the same as that of the biochemist. While the latter is interested primarily in studying the living *parts* of the organism (though not ignoring their relations to the whole), the aim of the experimental zoologist is, or should be, to understand the activity of the organism as a whole. Obviously he also may properly use the methods of the biochemist and the physiologist, but he runs up against difficulties at once. How is it possible, for example, to give any adequate account from this point of view of the processes of regulatory development? Living systems are immensely complex, and show "intrinsic potentialities" which are quite without parallel in the inorganic realm. The zoologist, therefore, while accepting what help he can from the chemist in the study of the physical and chemical properties of living matter, should not shirk this greater problem of the study of the distinctively vital properties of living systems; in this field "biology must be the mistress, not the servant of physics and chemistry—she must make her own foundations, and build on them fearlessly". Dr. Gray rejects the dogmatic application of mechanistic method in a refreshingly outspoken way. Further comment on these important and illuminating addresses is made in our leading article (p. 365).

U.S. National Recovery Act Oil Code

THE American petroleum industry has adopted a code of fair competition, which aims at adequate and economic supplies of petroleum and its products by eradicating such abuses in all branches of the industry as may cause fluctuations in supply inconsistent with actual demand. It further seeks to conserve and prevent wastage of natural resources; to rationalise internal organisation by standardising wages and improving labour conditions; and to give practical effect to the policy implied by the National Industrial Recovery Act. Production is to be balanced so far as possible against demand, as estimated by federal authority, allocated equitably among the several States by the said authority, and finally subdivided by State authorities into pool, lease and/or well quotas. Similarly, to prevent unbalanced accumulation of gasoline inventories in any part of the country, and to facilitate equitable access of refiners to the permissible supply of crude oil, the country is to be divided into refining districts by a federal agency authorised to declare proper ratios between inventories and sales of gasoline in the respective districts.

MARKETING conditions imposed by the oil code summarily enforce the posting of prices by retailers and wholesalers of all grades of petroleum; they will prevent deviation from such posted prices by rebates, allowances, etc. and establish a fixed schedule of credit pertaining to the whole industry. In addition, a detailed schedule of equipment prices to be used as a basis of purchase or sale between oil companies is appended. The terms of the code are to be enforced and the administrative duties carried out by a committee representing the industry and by a federal agency to be designated by the President. The federal agency will be responsible for estimates of petroleum demand and for recommendations re quotas, allocations and inventories as stated above. The industry as a whole is under obligation to supply such necessary technical data and statistical reports as may be required for the effective administration of the code.

IT is as yet early days to appreciate the full force of this unique recovery act in the United States and its influence on the economic and social life of the community as a whole, and already in other industries there are signs that its immediate results have not been up to the optimistic anticipations of its sponsors. As applied to the oil industry, it is clearly undergoing a most acid test, since no industry in the United States has suffered so much from lack of co-ordinating influences. Quite apart from the economics involved, obedience to the code must inevitably bring with it drastic changes in the technical control of the industry, particularly as it affects drilling, production, conservation of reserves and refinery practice. If it succeeds, its repercussions will be world-wide, for America having put her house of petroleum in order, it will be impossible for other countries not to come into line. The code as it stands is the nearest approach to State control of a key industry which has ever been framed in the United States.

The Rubber Research Association

THE present plight of the Research Association of British Rubber Manufacturers is a deplorable example of the results caused by an absence of any stabilised policy of financing industrial research. This Association was established in 1920, and has hitherto been maintained by voluntary subscriptions from individual manufacturing concerns, and by grants from the Department of Scientific and Industrial Research, out of the £1,000,000 fund set aside by Parliament in 1917 for industrial research in general. The Association has performed work of the utmost value to the community and to the industry as a whole. That work has had the effect of making the smaller units in the industry much more efficient, and it is to be feared that the resulting increase of efficiency in the smaller units has created a feeling of apprehension in some of the larger units, accompanied by an unwillingness—and even point blank refusal—to contribute further. Thus the value of the Association's work has contributed to its undoing. An endeavour was made by friends in the House of Commons to place its finances on a stable basis by promoting the Rubber Industry Bill, which provided for a small compulsory levy on all imports of raw rubber. After a troubled history the Bill was adopted by the Government last May: but later the Government dropped it, apparently in consequence of the opposition raised by some elements of the industry.

IT would be a national calamity if the valuable work of the Rubber Research Association were allowed to be stopped for want of adequate financial support. The Government has now made an offer to the Association to contribute on what may roughly be described as a pound per pound basis, that is, to contribute as much money as the Association can raise by voluntary contributions from the industry. At best, this can only leave the Association with a fluctuating income; and a fluctuating income is precisely the type of revenue that makes systematic planning ahead impossible. Anything short of stabilised revenue inevitably results in wasteful expenditure (as in the case of the Forestry Commission). It is applying rule of thumb methods to scientific work; and thus things move in a vicious circle, bringing about a negation of true economy. However, the last word has not been said on this subject. The Association is receiving powerful backing from influential quarters. It is understood that the Association of Chambers of Commerce, the British Science Guild, and the Association of Scientific Workers are taking joint and individual steps, with the view of securing more adequate financial support to enable the Research Association to tide over its period of difficulties, and to make possible the retention of its experienced technical and scientific staff.

Thomas Allan, F.R.S., 1777–1833

ON September 12, 1833, Thomas Allan, the Scottish mineralogist, died at the age of fifty-six years. Born in Edinburgh, he was educated at the High School and then entered his father's bank. On a visit to Paris, after the peace of Amiens of 1802, he made the acquaintance of some French men of science and began collecting minerals. In 1808, he published an alphabetical list of minerals in English, French and German, and afterwards contributed papers to the Royal Society and the Royal Society of Edinburgh. His name is intimately associated with that of the romantic Sir Charles Giesecke (1761–1833) otherwise Karl Ludwig Metzler—"a wanderer from Germany, learned in mineralogy, explorer, actor, journalist, Freemason, the friend of Mozart and of Schiller, and perhaps the original of William Meister". Giesecke, who had studied under Werner, had had a school of mineralogy at Copenhagen until the bombardment, and had then gone mineral collecting in Greenland. In 1811 he shipped a large collection of minerals to Denmark, but the ship being captured first by a French privateer and then by a British frigate, was brought to Leith and the minerals were purchased by Allan for £40. Two years later, Giesecke arrived in Hull with another collection and then learnt the fate of the first. Proceeding to Edinburgh, he was hospitably received and soon after was given the appointment of professor of mineralogy in the Royal Dublin Society. He died, in Dublin, a few months before Allan. In the study and improvement of his own collection Allan, for some years, was assisted by the Austrian geologist Wilhelm Haidinger (1795–1871) and it became the best in Scotland. After Allan's death it was sold and ultimately came into the possession of Robert Philip Greg (1826–1906), from whom it was purchased in 1860 for the Natural History Department of the British Museum.

Research Exhibit at the Shipping Exhibition

AT the Shipping, Engineering and Machinery Exhibition, which was opened at Olympia, London, on September 7, a comprehensive exhibit has been arranged by the Department of Scientific and Industrial Research to illustrate the work done by the Department itself and associated research bodies, to assist the British shipping and engineering industries. The William Froude Laboratory and the Engineering and Metrology Departments of the National Physical Laboratory, and the Chemical Research Laboratory have exhibits illustrating some of the investigations carried out at Teddington, while the Fuel Research Station, Greenwich, has one exhibit dealing with fires in bunkers and colliers, and another with pulverised fuel. The exhibit of the Chemical Research Laboratory illustrates the important investigations, carried out in many parts of the world, on sea-water corrosion. Progress in the iron, steel and non-ferrous metals industries is largely due to the British Non-Ferrous Metals Research Association, the British Cast Iron Research Association and the Industrial Research Council of the National Federation of Iron and Steel Manufacturers, all of which have exhibits illustrating their many activities. Their exhibits range from the new lead alloys for electric cable sheathings and heat-resisting cast irons, to the coke for coke ovens and blast furnaces, and steel ingots. It is safe to say that there is no engineering shop or shipbuilding yard in Great Britain which does not benefit from the researches illustrated at Olympia. The Exhibition will remain open until September 23.

The Expanding Universe

WE have been used to hearing strange things about the expanding universe. Prof. de Sitter contributes to the June issue of the Royal Astronomical Society's *Monthly Notices* an article which is largely of a non-mathematical character and will throw light on the subject for those of our readers who have been unable to follow the elaborate discussions of the last few years on the subject: he advances the quasi-paradoxical view that the *stars are older than the universe*. It is, he says, possible to adopt a point of view in which the "beginning of the universe" is no more remarkable a phenomenon than the passage of a comet through its perihelion. It is then possible to maintain a longer time scale for the individual stars—as is demanded by theories of stellar evolution based on Eddington's mass luminosity relation—than is accordant with the interval which has elapsed since the galaxies started expanding, as judged by the observed recession of the spiral nebulæ. It must be borne in mind that the expansion of the universe is the separation of galaxies, and leaves each galaxy unaltered, and that the galaxies can easily interpenetrate. The beginning of the universe, or minimum of one of the quantities connected with the universe, took place about ten thousand million years ago, but the stars are much older. At this minimum the galaxies interpenetrated: and during this interpenetration the chance of stellar encounters was, of course, greater than it is now that our galaxy is left to itself. Modern theories of the origin of the earth suppose that our planetary system is the result of a close approach to the sun of some star. Now the evidence of the earth's crust points to an age of the earth of this order of magnitude, and it appears conceivable that the earth was formed at the "beginning of the universe" but that the sun was not, the "beginning" of the universe being simply a time of minimum separation (indeed, interpenetration) of the galaxies, the stars in which had already been in existence for some time.

Progress in Facilities of Transport

A PUBLIC lecture, entitled "Transport for a Century", was delivered by Sir Henry Fowler on September 5, in connexion with the Leicester meeting of the British Association. Probably no single item has played so great a part in the advance of civilisation during the past hundred years as the progress in ease of transportation. The rapidity of actual transport of persons and material has effected a very great change indeed in the life of people and countries. It has been said that all transportation is material waste and if this is so, this source of waste has been very much reduced during the past century, although this may not always be realised as fully as it should. This reduction has been largely due to the improvement of roads, both for horse and power driven vehicles, resulting in greater efficiency, and applies both to roads of earth, stone, etc., and to those using iron and steel rails. It has been also due to the employment of mechanical means of propulsion not only on these roads but also through the air itself.

SIR HENRY FOWLER did not deal with propulsion through water, important as it is. He began with a reference to the Leicester and Swannington Railway, which formed so important a step in the commercial development of railways a century ago. This line was essentially due to the courage and forethought of the men of Leicester and its neighbourhood. Up to 1897, mechanical transport on roads was hindered by Government restrictions, with the result that Great Britain was ten years behind the Continent in starting development on these lines. Great Britain was also somewhat behind in transport in the air. In both cases, however, through the knowledge the country had in alloy steels, etc., and in engineering efficiency, it was possible to recover lost ground rapidly. The general scientific knowledge available assisted very materially in the advances in aeronautics. As a result Great Britain has been in the forefront in all types of speed of transportation in recent years. Sir Henry Fowler referred to the recent 15-ton motor unit for use in the development of fresh country both in the Dominions and Colonies. This has been produced under the supervision of the Overseas Mechanical Transport Directing Committee which was appointed by the Government. The lecture was concluded with a short film showing the performance and possibilities of this vehicle.

Recent Archæological Discoveries in Great Britain

SEVERAL announcements of archæological discoveries of considerable interest have been made within the last few days. Of these, the prehistoric settlement in Papa Westray, Orkney Islands, excites hope of a second Skara Brae. Two large stone buildings, said to be of a type new to Scottish archæology, have been exposed at Hower. The tops of the walls were covered by 6–8 ft. of sand, which had to be cleared away before the buildings were seen. One of the buildings was found to be in an excellent state of preservation, the walls standing to the height of 6 ft. The second, however, had suffered considerable damage. The two structures are connected by a passage and open on to a street, which, unfortunately, has disappeared before the encroachment of the sea. It has been possible to plan the structures ; but no evidence of the period of occupation has as yet been obtained. The excavations are being carried out by Mr. William Traill of Papa Westray and Mr. W. Kirkness of Edinburgh. A second discovery comes from the Isle of Man, where a gardener at Douglas unearthed a bronze age urn beneath a flat slate slab. There was no indication of the existence of a cist or mound. The urn is 17 in. high and 12 in. wide at the mouth, and undecorated, except for irregularly placed dots on the lip. An unusual feature is that the urn stood on its rounded bottom, under which was a white pebble propping it up. Further search revealed the broken remains of another urn about 5 ft. to the south. Underneath this was a platform of black earth with carbon, in some places showing much burning. It is possible, therefore, that this second find represents the vestiges of the incineration, of which the food vessel previously found formed a part. The find is described in the *Times* of September 5.

IN the same issue of the *Times* will be found a report on recent excavations in Salmonsbury Camp at Bourton-on-the-Stour, Gloucestershire. Previous discoveries of Iron, Roman and Saxon Age have pointed to this district as being of considerable archæological interest. Salmonsbury Camp itself is an Iron Age structure of some fifty-six acres in extent, which is now being excavated by a local committee under the supervision of Mr. G. C. Dunning of the London Museum. An early Iron Age hut-site was first discovered near the centre of the camp and several similar hut-sites have since been found in other parts. These belong to the first century B.C. Twelve inches above the central Iron Age hut was the floor, partially cobbled and paved with flat stones, of a Roman hut, which yielded pottery and a third century coin. Intervening between these two periods of occupation came evidence of Belgic invasion, in the form of a Belgic hut within the ramparts on the north-west side of the camp. This hut proved rich in finds of pottery, two iron brooches, iron knives, pins, objects of bone, a stone spindle whorl, and worked flints. Fragments of iron and bronze slag and clay point to metal and pottery industries. It is thought that the numerous finds belonging to the Belgic period on the site, point to an invasion of those people, and to them, too, is attributed one of the less pleasing characteristics of the occupants of the site, namely the practice of cannibalism, indicated by the presence of the scattered bones of a female skeleton, some of which appear to have been split to obtain the marrow.

Electric Discharge Lamps

AT the tenth annual conference at Margate of the Association of Public Lighting Engineers, a paper was read on September 5 by Mr. G. H. Wilson on electric discharge lamps and their applications to public lighting. These lamps, which mark a considerable advance in the efficiency of light production, emit light not because any solid is made 'white hot' (as in the case of the filament of the ordinary electric lamp) but because a gas or vapour is 'excited' electrically. When a suitable gas at low pressure is sealed into a glass tube having an electrode at either end, it conducts electricity and light is emitted, the colour of which depends upon the gas used. Mercury vapour produces a blue light, helium an ivory white,

(*Continued on p.* 405.)

Supplement to NATURE

No. 3332 SEPTEMBER 9, 1933

Some Chemical Aspects of Life

By Sir Frederick Gowland Hopkins, pres.r.s., President of the British Association

Presidential address delivered at Leicester on September 6, 1933

I

THE British Association returns to Leicester with assurance of a welcome as warm as that received twenty-six years ago, and of hospitality as generous. The renewed invitation and the ready acceptance speak of mutual appreciation born of the earlier experience. Hosts and guests have to-day reasons for mutual congratulations. The Association on its second visit finds Leicester altered in important ways. It comes now to a city duly chartered and the seat of a bishopric. It finds there a centre of learning, many fine buildings which did not exist on the occasion of the first visit, and many other evidences of civic enterprise. The citizens of Leicester on the other hand will know that since they last entertained it the Association has celebrated its centenary, has four times visited distant parts of the Empire, and has maintained unabated through the years its useful and important activities.

In 1907 the occupant of the presidential chair was Sir David Gill, the eminent astronomer who, unhappily, like many who listened to his address, is with us no more. Sir David dealt in that address with aspects of science characterised by the use of very exact measurement. The exactitude which he prized and praised has since been developed by modern physics and is now so great that its methods have real æsthetic beauty. In contrast, I have to deal with a branch of experimental science which, because it is concerned with living organisms, is in respect of measurement on a different plane. Of the very essence of biological systems is an ineludable complexity, and exact measurement calls for conditions here unattainable. Many may think, indeed, though I am not claiming it here, that in studying life we soon meet with aspects which are non-metrical. I would have you believe, however, that the data of modern biochemistry which will be the subject of my remarks were won by quantitative methods fully adequate to justify the claims based upon them.

Though speculations concerning the origin of life have given intellectual pleasure to many, all that we yet know about it is that we know nothing. Sir James Jeans once suggested, though not with conviction, that it might be a disease of matter—a disease of its old age! Most biologists, I think, having agreed that life's advent was at once the most improbable and the most significant event in the history of the universe, are content for the present to leave the matter there.

We must recognise, however, that life has one attribute that is fundamental. Whenever and wherever it appears, the steady increase of entropy displayed by all the rest of the universe is then and there arrested. There is no good evidence that in any of its manifestations life ultimately evades the second law of thermodynamics, but in the downward course of the energy-flow it interposes a barrier and dams up a reservoir which provides potential for its own remarkable activities. The arrest of energy degradation in this sense is indeed a primary biological concept. Related to it and of equal importance is the concept of organisation.

It is almost impossible to avoid thinking and talking of life in this abstract way, but we perceive it, of course, only as manifested in organised material systems, and it is in them we must seek the mechanisms which arrest the fall of energy. Evolution has established division of labour here. From far back the wonderfully efficient functioning of structures containing chlorophyll has, as is well known, provided the trap which arrests and transforms radiant energy—fated otherwise to degrade—and so provides power for nearly the whole living world. It is impossible to believe, however, that such a complex mechanism was associated with life's earliest stages. Existing organisms illustrate what was perhaps an earlier method. The so-called autotrophic bacteria obtain energy for growth by the catalysed oxidation of materials belonging wholly to the inorganic world; such as sulphur, iron or ammonia, and even free hydrogen. These organisms dispense with solar energy, but they have lost in the evolutionary race because their method lacks economy. Other existing organisms, certain purple bacteria, seem to have taken a step towards greater economy, without reaching that of the green cell. They dispense with free oxygen and yet obtain energy from the inorganic world. They control a process in which carbon dioxide is reduced and hydrogen sulphide simultaneously oxidised. The molecules of the former are activated by solar energy which their pigmentary equipment enables these organisms to arrest.

Are we to believe that life still exists in association with systems that are much more simply organised than any bacterial cell? The very minute filter-passing viruses which, owing to their causal relations with disease, are now the subject of intense study, awaken deep curiosity with respect to this question. We cannot yet claim to know whether or not they are living organisms. In some sense they grow and multiply, but, so far as we yet know with certainty, only when inhabitants of living cells. If they are nevertheless living, this would suggest that they have no independent power of obtaining energy and so cannot represent for us the earliest forms in which life appeared. At present, however, judgment on their biological significance must be suspended. The fullest understanding of all the methods by which energy may be acquired for life's processes is much to be desired.

In any event, every living unit is a transformer of energy however acquired, and the science of biochemistry is deeply concerned with these transformations. It is with aspects of that science that I am to deal, and if to them I devote much of my address, my excuse is that since it became a major branch of inquiry, biochemistry has had no exponent in the presidential chair I am fortunate enough to occupy.

As a progressive scientific discipline, it belongs to the present century. From the experimental physiologists of the last century it obtained a charter, and, from a few pioneers of its own, a promise of success; but for the furtherance of its essential aim, that century left it but a small inheritance of facts and methods. By its essential or ultimate aim, I myself mean an adequate and acceptable description of molecular dynamics in living cells and tissues.

II

When the British Association began its history in 1831, the first artificial synthesis of a biological product was but three years old. Primitive faith in a boundary between the organic and the inorganic which could never be crossed, was only just then realising that its foundations were gone. Since then, during the century of its existence, the Association has seen the pendulum swing back and forth between frank physico-chemical conceptions of life and various modifications of vitalism. It is characteristic of the present position and spirit of science that sounds of the long conflict between mechanists and vitalists are just now seldom heard. It would almost seem, indeed, that tired of fighting in a misty atmosphere, each has retired to his tent to await with wisdom the light of further knowledge. Perhaps, however, they are returning to the fight disguised as determinist and indeterminist respectively. If so, the outcome will be of great interest.

In any event, I feel fortunate in a belief that what I have to say will not, if rightly appraised, raise the old issues. To claim, as I am to claim, that a description of its active chemical aspects must contribute to any adequate description of life is not to imply that a living organism is no more than a physico-chemical system. It implies that at a definite and recognisable level of its dynamic organisation, an organism can be logically described in physico-chemical terms alone. At such a level, indeed, we may hope ultimately to arrive at a description which is complete in itself, just as descriptions at the morphological level of organisation may be complete in themselves. There may be yet higher levels calling for discussion in quite different terms.

I wish, however, to remind you of a mode of thought concerning the material basis of life, which though it prevailed when physico-chemical interpretations were fashionable, was yet almost as inhibitory to productive chemical thought and study as any of the claims of vitalism. This was the conception of that material basis as a single entity, as a definite though highly complex chemical compound. Up to the end of the last century and even later, the term 'protoplasm' suggested such an entity to many minds. In his brilliant presidential address at the British Association's meeting at Dundee twenty-one years ago, Sir Edward Sharpey-Schafer, after remarking that the elements composing living substances are few in number, went on to say: "The combination of these elements into a colloid compound represents the physical basis of life, and when the chemist succeeds in building up this compound it will, without doubt, be found to exhibit the phenomena which we are in the habit of associating with the term 'life'." Such a compound would seem to correspond with the 'protoplasm' of many biologists, though treated perhaps with too little respect. The presidential claim might have seemed to encourage the biochemist, but the goal suggested would have proved elusive, and the path of endeavour has followed other lines.

So long as the term 'protoplasm' retains a morphological significance as in classical cytology, it may be even now convenient enough, though always denoting an abstraction. In so far, however, as the progress of metabolism with all the vital activities which it supports was ascribed, in concrete thought, to hypothetical qualities emergent from a protoplasmic complex in its integrity, or when substances were held to suffer change only because in each living cell they are first built up, with loss of their own molecular structure and identity, into this complex, which is itself the inscrutable seat of cyclic change, then serious obscurantism was involved.

Had such assumptions been justified, the old taunt that when the chemist touches living matter it immediately becomes dead matter would also have been justified. A very distinguished organic chemist, long since dead, said to me in the late 'eighties: "The chemistry of the living? That is the chemistry of protoplasm; that is superchemistry; seek, my young friend, for other ambitions."

Research, however, during the present century, much of which has been done since the British Association last met in Leicester, has yielded knowledge to justify the optimism of the few who started to work in those days. Were there time, I might illustrate this by abundant examples; but I think a single illustration will suffice to demonstrate how progress during recent years has changed the outlook for biochemistry. I will ask you to note the language used thirty years ago to describe the chemical events in active muscle and compare it with that used now. In 1895, Michael Foster, a physiologist of deep vision, dealing with the respiration of tissues, and in particular with the degree to which the activity of muscle depends on its contemporary oxygen supply, expounded the current view which may be thus briefly summarised. The oxygen which enters the muscle from the blood is not involved in immediate oxidations, but is built up into the substance of the muscle. It disappears into some protoplasmic complex on which its presence confers instability. This complex, like all living substance, is to be regarded as incessantly undergoing changes of a double kind, those of building up and those of breaking down. With activity the latter predominates, and in the case of muscle the complex in question explodes, as it were, to yield the energy for contraction. "We cannot yet trace," Foster comments, "the steps taken by the oxygen from the moment it slips from the blood into the muscle substance to the moment when it issues united with carbon as carbonic acid. The whole mystery of life lies hidden in that process, and for the present we must be content with simply knowing the beginning and the end."

What we feel entitled to say to-day concerning the respiration of muscle and of the events associated with its activity requires, as I have suggested, a different language, and for those not interested in technical chemical aspects the very change of language may yet be significant. The conception of continuous building up and continuous breakdown of the muscle substance as a whole, has but a small element of truth. The colloidal muscle structure is, so to speak, an apparatus, relatively stable even as a whole when metabolism is normal, and in essential parts very stable. The chemical reactions which occur in that apparatus have been followed with a completeness which is, I think, striking. It is carbohydrate stores, as distinct from the apparatus (and in certain circumstances also fat stores), which undergo steady oxidation and are the ultimate sources of energy for muscular work. Essential among successive stages in the chemical breakdown of carbohydrate which necessarily precede oxidation is the intermediate combination of a sugar (a hexose) with phosphoric acid to form an ester. This happening is indispensable for the progress of the next stage, namely, the production of lactic acid from the sugar, which is an anærobic process.

The precise happenings to the hexose sugar while in combination with phosphoric acid are from a chemical point of view remarkable. Very briefly stated they are these. One half of the sugar molecule is converted into a molecule of glycerin and the other half into one of pyruvic acid. Now with loss of two hydrogen atoms glycerin yields lactic acid, and, with a gain of the same, pyruvic acid also yields lactic acid. The actual happening then is that hydrogen is transferred from the glycerin molecule while still combined with phosphoric acid to the pyruvic acid molecule, with the result that two molecules of lactic acid are formed*. The lactic acid is then, during a cycle of change which I must not stop to discuss, oxidised to yield the energy required by the muscle.

The energy from this oxidation, however, is by no means directly available for the mechanical act of contraction. The oxidation occurs indeed after and not before or during a contraction. The energy it liberates secures, however, the endothermic resynthesis of a substance, creatin phosphate, of which the breakdown at an earlier stage in the sequence of events is the more immediate source of energy for contraction. Even more complicated are these chemical relations, for it would seem that in the transference of energy from its source in the oxidation of carbohydrate to the system which synthesises creatin phosphate, yet another reaction intervenes, namely, the alternating breakdown and resynthesis of the substance adenyl pyrophosphate.

The sequence of these chemical reactions in muscle has been followed and their relation in time to the phases of contraction and relaxation is established. The means by which energy is transferred from one reacting system to another has until lately been obscure, but current work is throwing light upon this interesting question, and it is just beginning (though only beginning) to show how at the final stage the energy of the reactions is converted into the mechanical response. In parenthesis, it may be noted as an illustration of the unity of life that the processes which occur in the living yeast cell in its dealings with sugars are closely similar to those which proceed in living muscle. In the earlier stages they are identical and we now know where they part company. You may be astonished at the complexity of the events which underlie the activity of a muscle, but you must remember that it is a highly specialised machine. A more direct burning of the fuel could not fit into its complex organisation. I am more particularly concerned to feel that my brief summary of the facts will make clear how much more definite, how much more truly chemical, is our present knowledge than that available when Michael Foster wrote.

* Otto Meyerhof, NATURE, Sept. 2, p. 337 and Sept. 9, p. 373.

Ability to recognise the progress of such definite ordered chemical reactions in relation to various aspects of living activity characterises the current position in biochemistry. I have chosen the case of muscle, and it must serve as my only example, but many such related and ordered reactions have been studied in other cells and tissues, from bacteria to the brain. Some prove general, some more special. Although we are far indeed from possessing a complete picture in any one case, we are beginning in thought to fit not a few pieces together. We are on a line safe for progress.

I must perforce limit the field of my discussion, and in what follows, my special theme will be the importance of molecular structure in determining the properties of living systems. I wish you to believe that molecules display in such systems the properties inherent in their structure even as they do in the laboratory of the organic chemist. The theme is no new one, but its development illustrates as well as any other, and to my own mind perhaps better than any other, the progress of biochemistry.

Not long ago a prominent biologist, believing in protoplasm as an entity, wrote: "But it seems certain that living protoplasm is not an ordinary chemical compound, and therefore can have no molecular structure in the chemical sense of the word." Such a belief was common. One may remark, moreover, that when the development of colloid chemistry first brought its indispensable aid towards an understanding of the biochemical field, there was a tendency to discuss its bearing in terms of the less specific properties of colloid systems, phase-surfaces, membranes, and the like, without sufficient reference to the specificity which the influence of molecular structure, wherever displayed, impresses on chemical relations and events. In emphasising its importance, I shall leave no time for dealing with the nature of the colloid structures of cells and tissues, all important as they are. I shall continue to deal, though not again in detail, with chemical reactions as they occur within those structures. Only this much must be said. If the colloid structures did not display highly specialised molecular structure at their surface, no reactions would occur ; for here catalysis occurs. Were it not equipped with catalysts every living unit would be a static system.

It is well known that a catalyst is an agent which plays only a temporary part in chemical events which it nevertheless determines and controls. It reappears unaltered when the events are completed. The phenomena of catalysis, though first recognised early in the last century, entered but little into chemical thought or enterprise, until only a few years ago they were shown to have great importance for industry. Yet catalysis is one of the most significant devices of Nature, since it has endowed living systems with their fundamental character as transformers of energy, and all evidence suggests that it must have played an indispensable part in the living universe from the earliest stages of evolution.

The catalysts of a living cell are the enzymic structures which display their influences at the surface of colloidal particles or at other surfaces within the cell. Current research continues to add to the great number of these enzymes which can be separated from, or recognised in, living cells and tissues, and to increase our knowledge of their individual functions.

A molecule within the system of the cell may remain in an inactive state and enter into no reactions until at one such surface it comes in contact with an enzymic structure which displays certain adjustments to its own structure. While in such association, the inactive molecule becomes (to use a current term) 'activated', and then enters on some definite path of change. The one aspect of enzymic catalysis which for the sake of my theme I wish to emphasise is its high specificity. An enzyme is in general adjusted to come into effective relations with one kind of molecule only, or at most with molecules closely related in their structure. Evidence based on kinetics justifies the belief that some sort of chemical combination between enzyme and related molecule precedes the activation of the latter, and for such combinations there must be close correlation in structure. Many will remember that long ago Emil Fischer recognised that enzymic action distinguishes even between two optical isomers and spoke of the necessary relation being as close as that of key and lock.

There is an important consequence of this high specificity in biological catalysis to which I invite special attention. A living cell is the seat of a multitude of reactions, and in order that it should retain in a given environment its individual identity as an organism, these reactions must be highly organised. They must be of determined nature and proceed mutually adjusted with respect to velocity, sequence, and in all other relations. They must be in dynamic equilibrium as a whole and must return to it after disturbance. Now if of any group of catalysts, such as are found in the equipment of a cell, each one exerts limited and highly specific influence, this very specificity must be a potent factor in making for organisation.

Consider the case of any individual cell in due relations with its environment, whether an internal environment as in the case of the tissue cells of higher animals, or an external environment as in the case of unicellular organisms. Materials for maintenance of the cell enter it from the environment. Discrimination among such materials is primarily determined by permeability relations, but of deeper significance in that selection is the specificity of the cell catalysts. It has often been said that the living cell differs from all non-living systems in its power of selecting from a heterogeneous environment the right material for the maintenance of its structure and activities. It is, however, no vital act but the nature of its specific catalysts which determines what it effectively 'selects'. If a molecule gains entry into the cell and meets no catalytic influence capable of activating it, nothing further happens save for certain ionic and osmotic adjustments. Any molecule which does meet an adjusted enzyme cannot fail to suffer change and become directed into some one of the paths of metabolism.

It must here be remembered, moreover, that enzymes as specific catalysts not only promote reactions, but also determine their direction. The glucose molecule, for example, though its inherent chemical potentialities are, of course, always the same, is converted into lactic acid by an enzyme system in muscle but into alcohol and carbon dioxide by another in the yeast cell. It is important to realise that diverse enzymes may act in succession and that specific catalysis has directive as well as selective powers. If it be syntheses in the cell which are most difficult to picture on such lines, we may remember that biological syntheses can be, and are, promoted by enzymes, and there are sufficient facts to justify the belief that a chain of specific enzymes can direct a complex synthesis along lines predetermined by the nature of the enzymes themselves. I should like to develop this aspect of the subject even further, but to do so might tax your patience. I should add that enzyme control, though so important, is not the sole determinant of chemical organisation in a cell. Other aspects of its colloidal structure play their part.

III

It is surely at that level of organisation, which is based on the exact co-ordination of a multitude of chemical events within it, that a living cell displays its peculiar sensitiveness to the influence of molecules of special nature when these enter it from without. The nature of very many organic molecules is such that they may enter a cell and exert no effect. Those proper to metabolism follow, of course, the normal paths of change. Some few, on the other hand, influence the cell in very special ways. When such influence is highly specific in kind, it means that some element of structure in the entrant molecule is adjusted to meet an aspect of molecular structure somewhere in the cell itself. We can easily understand that in a system so minute the intrusion even of a few such molecules may so modify existing equilibria as to affect profoundly the observed behaviour of the cell.

Such relations, though by no means confined to them, reach their greatest significance in the higher organisms, in which individual tissues, chemically diverse, differentiated in function and separated in space, so react upon one another through chemical agencies transmitted through the circulation as to co-ordinate by chemical transport the activities of the body as a whole. Unification by chemical means must to-day be recognised as a fundamental aspect of all such organisms. In all of them it is true that the nervous system has pride of place as the highest seat of organising influence, but we know to-day that even this influence is often, if not always, exerted through properties inherent in chemical molecules. It is indeed most significant for my general theme to realise that when a nerve impulse reaches a tissue the sudden production of a definite chemical substance at the nerve ending may be essential to the response of that tissue to the impulse.

It is a familiar circumstance that when an impulse passes to the heart by way of the vagus nerve fibres the beat is slowed, or, by a stronger impulse, arrested. That is, of course, part of the normal control of the heart's action. Now it has been shown that, whenever the heart receives vagus impulses, the substance acetyl choline is liberated within the organ. To this fact is added the further fact that, in the absence of the vagus influence, the artificial injection of minute graded doses of acetyl choline so acts upon the heart as to reproduce in every detail the effects of graded stimulation of the nerve.

Moreover, evidence is accumulating to show that in the case of other nerves belonging to the same morphological group as the vagus, but supplying other tissues, this same liberation of acetyl choline accompanies activity, and the chemical action of this substance upon such tissues again produces effects identical with those observed when the nerves are stimulated. More may be claimed. The functions of another group of nerves are opposed to those of the vagus group ; impulses, for example, through certain fibres accelerate the heart beat. Again a chemical substance is liberated at the endings of such nerves, and this substance has itself the property of accelerating the heart. We find then that such organs and tissues respond only indirectly to whatever non-specific physical change may reach the nerve ending. Their direct response is to the influence of particular molecules with an essential structure, when these intrude into their chemical machinery.

It follows that the effect of a given nerve stimulus may not be confined to the tissue which it first reaches. There may be humeral transmissions of its effect, because the liberated substance enters the lymph and blood. This again may assist the co-ordination of events in the tissues.

From substances produced temporarily and locally and by virtue of their chemical properties translating for the tissues the messages of nerves, we may pass logically to consideration of those active substances which carry chemical messages from organ to organ. Such in the animal body are produced continuously in specialised organs, and each has its special seat or seats of action where it finds chemical structures adjusted in some sense or other to its own.

I shall here be on familiar ground, for that such agencies exist, and bear the name of hormones, is common knowledge. I propose only to indicate how many and diverse are their functions as revealed by recent research, emphasising the fact that each one is a definite and relatively simple substance with properties that are primarily chemical and in a derivate sense physiological.

Our clear recognition of this, based at first on a couple of instances, began with this century, but our knowledge of their number and nature is still growing rapidly to-day.

We have long known, of course, how essential and profound is the influence of the thyroid gland in maintaining harmonious growth in the body, and in controlling the rate of its metabolism. Three years ago a brilliant investigation revealed the exact molecular structure of the substance—thyroxin—which is directly responsible for these effects. It is a substance of no great complexity. The constitution of adrenalin has been longer known and likewise its remarkable influence in maintaining a number of important physiological adjustments. Yet it is again a relatively simple substance. I will merely remind you of secretin, the first of these substances to receive the name of hormone, and of insulin, now so familiar because of its importance in the metabolism of carbohydrates and its consequent value in the treatment of diabetes. The most recent growth of knowledge in this field has dealt with hormones which, in most remarkable relations, co-ordinate the phenomena of sex.

It is the circulation of definite chemical substances produced locally that determines, during the growth of the individual, the proper development of all the secondary sexual characters. The properties of other substances secure the due progress of individual development from the unfertilised ovum to the end of fœtal life. When an ovum ripens and is discharged from the ovary a substance, now known as œstrin, is produced in the ovary itself, and so functions as to bring about all those changes in the female body which make secure the fertilisation of the ovum. On the discharge of the ovum new tissue, constituting the so-called *corpus luteum*, arises in its place. This then produces a special hormone which in its turn evokes all those changes in tissues and organs that secure a right destiny for the ovum after it has been fertilised. It is clear that these two hormones do not arise simultaneously, for they must act in alternation, and it becomes of great interest to know how such succession is secured. The facts here are among the most striking. Just as higher nerve centres in the brain control and co-ordinate the activities of lower centres, so it would seem do hormones, functioning at, so to speak, a higher level in organisation, co-ordinate the activities of other hormones. It is a substance produced in the anterior portion of the pituitary gland situated at the base of the brain which, by circulating to the ovary, controls the succession of its hormonal activities. The cases I have mentioned are far from exhausting the numerous hormonal influences now recognised.

For full appreciation of the extent to which chemical substances control and co-ordinate events in the animal body by virtue of their specific molecular structure, it is well not to separate too widely in thought the functions of hormones from those of vitamins. Together they form a large group of substances of which every one exerts upon physiological events its own indispensable chemical influence.

Hormones are produced in the body itself, while vitamins must be supplied in the diet. Such a distinction is, in general, justified. We meet occasionally, however, an animal species able to dispense with an external supply of this or that vitamin. Evidence shows, however, that individuals of that species, unlike most animals, can in the course of their metabolism synthesise for themselves the vitamin in question. The vitamin then becomes a hormone. In practice the distinction may be of great importance, but for an understanding of metabolism the functions of these substances are of more significance than their origin.

The present activity of research in the field of vitamins is prodigious. The output of published papers dealing with original investigations in the field has reached nearly a thousand in a single year. Each of the vitamins at present known is receiving the attention of numerous observers in respect both of its chemical and biological properties, and though many publications deal, of course, with matters of detail, the accumulation of significant facts is growing fast.

It is clear that I can cover but little ground in any reference to this wide field of knowledge. Some aspects of its development have been interesting enough. The familiar circumstance that attention was directed to the existence of one vitamin (B_1 so called) because populations in the East took to eating milled rice instead of the whole grain ; the gradual growth of evidence which links the physiological activities of another vitamin (D) with the influence of solar radiation on the body, and has shown that they are thus related, because rays of definite wave-length convert an inactive precursor into the active vitamin, alike when acting on foodstuffs or on the surface of the living body ; the fact again that the recent isolation of vitamin C, and the accumulation of evidence for its nature started from the observation that the cortex of the adrenal gland displayed strongly reducing properties ; or yet again the proof that a yellow pigment widely distributed among plants, while not the vitamin itself, can be converted within the body into vitamin A ; these and other aspects of vitamin studies will stand out as interesting chapters in the story of scientific investigation.

In this very brief discussion of hormones and vitamins I have so far referred only to their functions as manifested in the animal body. Kindred substances, exerting analogous functions, are, however, of wide and perhaps of quite general biological importance. It is certain that many microorganisms require a supply of vitamin-like substances for the promotion of growth, and recent research of a very interesting kind has demonstrated in the higher plants the existence of specific substances produced in special cells which stimulate growth in other cells, and so in the plant as a whole. These so-called auxines are essentially hormones.

It is of particular importance to my present theme and a source of much satisfaction to know that our knowledge of the actual molecular structure of hormones and vitamins is growing fast. We have already exact knowledge of the kind in respect to not a few. We are indeed justified in believing that within a few years such knowledge will be extensive enough to allow a wide view of the correlation between molecular structure and physiological activity. Such correlation has long been sought in the case of drugs, and some generalisations have been demonstrated. It should be remembered, however, that until quite lately only the structure of the drug could be considered. With increasing knowledge of the tissue structures, pharmacological actions will become much clearer.

I cannot refrain from mentioning here a set of relations connected especially with the phenomena of tissue growth which are of particular interest. It will be convenient to introduce some technical chemical considerations in describing them, though I think the relations may be clear without emphasis being placed on such details. The vitamin, which in current usage is labelled 'A', is essential for the general growth of an animal. Recent research has provided much information as to its chemical nature. Its molecule is built up of units which possess what is known to chemists as the isoprene structure. These are condensed in a long carbon chain which is attached to a ring structure of a specific kind. Such a constitution relates it to other biological compounds, in particular to certain vegetable pigments, one of which, a carotene, so called, is the substance which I have mentioned as being convertible into the vitamin. For the display of an influence upon growth, however, the exact details of the vitamin's proper structure must be established.

Now turning to vitamin D, of which the activity is more specialised, controlling as it does the growth of bone in particular, we have learnt that the unit elements in its structure are again isoprene radicals ; but instead of forming a long chain as in vitamin A they are united into a system of condensed rings. Similar rings form the basal components of the molecules of sterols, substances which are normal constituents of nearly every living cell. It is one of these, inactive itself, which ultra-violet radiation converts into vitamin D. We know that each of these vitamins stimulates growth in tissue cells.

Next consider another case of growth stimulation, different because pathological in nature. It is well known that long contact with tar induces a cancerous growth of the skin. Very important researches have recently shown that particular constituents in the tar are alone concerned in producing this effect. It is being further demonstrated that the power to produce cancer is associated with a special type of molecular structure in these constituents. This structure, like that of the sterols, is one of condensed rings, the essential difference being that (in chemical language) the sterol rings are hydrogenated, whereas those in the cancer-producing molecules are not. Hydrogenation indeed destroys the activity of the latter. Recall, however, the ovarian hormone œstrin. Now the molecular structure of œstrin has the essential ring structure of a sterol, but one of the constituent rings is not hydrogenated. In a sense, therefore, the chemical nature of œstrin links vitamin D with that of cancer-producing substances. Further, it is found that substances with pronounced cancer-producing powers may produce effects in the body like those of œstrin.

It is difficult when faced with such relations not to wonder whether the metabolism of sterols, which when normal can produce a substance stimulating physiological growth, may in very special circumstances be so perverted as to produce within living cells a substance stimulating pathological growth. Such a suggestion must, however, with present knowledge, be very cautiously received. It is wholly without experimental proof. My chief purpose in this reference to this very interesting set of relations is to emphasise once more the significance of chemical structure in the field of biological events.

Only the end results of the profound influence which minute amounts of substances with adjusted structure exert upon living cells or tissues can be observed in the intact bodies of man or animals. It is doubtless because of the elaborate and sensitive organisation of chemical events in every tissue cell that the effects are proportionally so great.

It is an immediate task of biochemistry to explore the mechanism of such activities. It must learn to describe in objective chemical terms precisely how and where such molecules as those of hormones and vitamins intrude into the chemical events of metabolism. It is indeed now beginning this task, which is by no means outside the scope of its methods. Efforts of this and of similar kind cannot fail to be associated with a steady increase in knowledge of the whole field of chemical organisation in living organisms, and to this increase we look forward with confidence. The promise is there. Present methods can still go far, but I am convinced that progress of the kind is about to gain great impetus from the application of those new methods of research which chemistry is inheriting from physics : X-ray analysis ; the current studies of unimolecular surface films and of chemical reactions at surfaces ; modern spectroscopy ; the quantitative developments of photo-chemistry ; no branch of inquiry stands to gain more from such advances in technique than does biochemistry at its present stage. Especially is this true in the case of the colloidal structure of living systems, of which in this address I have said so little.

IV

As an experimental science, biochemistry, like classical physiology, and much of experimental biology, has obtained, and must continue to obtain, many of its data from studying parts of the organism in isolation, but parts in which dynamic events continue. Though fortunately it has also methods of studying reactions as they occur in intact living cells, intact tissues, and, of course, in the intact animal, it is still entitled to claim that its studies of parts are consistently developing its grasp of the wholes it desires to describe, however remote that grasp may be from finality. Justification for any such claim has been challenged in advance from a certain philosophic point of view. Not from that of General Smuts, though in his powerful address which signalised our centenary meeting he, like many philosophers to-day, emphasised the importance of properties which emerge from systems in their integrity, bidding us remember that a part while in the whole is not the same as the part in isolation. He hastened to admit in a subsequent speech, however, that for experimental biology, as for any other branch of science, it is logical and necessary to approach the whole through its parts. Nor again is the claim challenged from the point of view of such a teacher as A. N. Whitehead, though in his philosophy of organic mechanism there is no real entity of any kind without internal and multiple relations, and each whole is more than the sum of its parts. I nevertheless find *ad hoc* statements in his writings which directly encourage the methods of biochemistry.

In the teachings of J. S. Haldane, however, the value of such methods have long been directly challenged. Some will perhaps remember that in an address to Section I, twenty-five years ago, he described a philosophic point of view which he has courageously maintained in many writings since. Dr. Haldane holds that to the enlightened biologist a living organism does not present a problem for analysis ; it is, *qua* organism, axiomatic. Its essential attributes are axiomatic ; heredity, for example, is for biology not a problem but an axiom. "The problem of Physiology is not to obtain piecemeal physico-explanations of physiological processes" (I quote from the 1885 address), "but to discover by observation and experiment the relatedness to one another of all the details of structure and activity in each organism as expressions of its nature as one organism."

I cannot pretend adequately to discuss these views here. They have often been discussed by others, not always perhaps with understanding. What is true in them is subtle, and I doubt if their author has ever found the right words in which to bring to most others a conviction of such truth. It is involved in a world outlook. What I think is scientifically faulty in Haldane's teaching is the a priori element which leads to bias in the face of evidence. The task he sets for the physiologist seems vague to most people, and he forgets that with good judgment a study of parts may lead to an intellectual synthesis of value. In 1885 he wrote: "That a meeting-point between Biology and Physical Science may at some time be found there is no reason for doubting. But we may confidently predict that if that meeting-point is found, and one of the two sciences is swallowed up, that one will not be Biology." He now claims indeed that biology has accomplished the heavy meal, because physics has been compelled to deal no longer with Newtonian entities but, like the biologist, with organisms such as the atom proves to be. Is it not then enough for my present purpose to remark on the significance of the fact that not until certain atoms were found spontaneously splitting piecemeal into parts, and others were afterwards so split in the laboratory, did we really know anything about the atom as a whole.

At this point, however, I will ask you not to suspect me of claiming that all the attributes of living systems or even the more obvious among them are necessarily based upon chemical organisation alone. I have already expressed my own belief that this organisation will account for one striking characteristic of every living cell—its ability, namely, to maintain a dynamic individuality in diverse environments. Living cells display other attributes even more characteristic of themselves; they grow, multiply, inherit qualities and transmit them. Although to distinguish levels of organisation in such systems may be to abstract from reality, it is not illogical to believe that such attributes as these are based upon organisation at a level which is in some sense higher than the chemical level. The main necessity from the point of view of biochemistry is then to decide whether nevertheless at its own level, which is certainly definable, the results of experimental studies are self-contained and consistent. This is assuredly true of the data which biochemistry is now acquiring. Never during its progress has chemical consistency shown itself to be disturbed by influences of any ultra-chemical kind.

Moreover, before we assume that there is a level of organisation at which chemical controlling agencies must necessarily cease to function, we should respect the intellectual parsimony taught by Occam and be sure of their limitations before we seek for super-chemical entities as organisers. There is no orderly succession of events which would seem less likely to be controlled by the mere chemical properties of a substance than the cell divisions and cell differentiation which intervene between the fertilised ovum and the finished embryo. Yet it would seem that a transmitted substance, a hormone in essence, may play an unmistakable part in that remarkable drama. It has for some years been known that, at an early stage of development, a group of cells forming the so-called 'organiser' of Spemann induces the subsequent stages of differentiation in other cells. The latest researches seem to show that a cell-free extract of this 'organiser' may function in its place. The substance concerned is, it would seem, not confined to the 'organiser' itself, but is widely distributed outside, though not in, the embryo. It presents, nevertheless, a truly remarkable instance of chemical influence.

It would be out of place in such a discourse as this to attempt any discussion of the psycho-physical problem. However much we may learn about the material systems which, in their integrity, are associated with consciousness, the nature of that association may yet remain a problem. The interest of that problem is insistent and it must be often in our thoughts. Its existence, however, justifies no pre-judgments as to the value of any knowledge of a consistent sort which the material systems may yield to experiment.

V

It has become clear, I think, that chemical modes of thought, whatever their limitation, are fated profoundly to affect biological thought. If, however, the biochemist should at any time be inclined to overrate the value of his contributions to biology, or to underrate the magnitude of problems outside his province, he will do well sometimes to leave the laboratory for the field, or to seek even in the museum a reminder of that infinity of adaptations of which life is capable. He will then not fail to work with a humble mind, however great his faith in the importance of the methods which are his own.

It is surely right, however, to claim that in passing from its earlier concern with dead biological products to its present concern with active processes within living organisms, biochemistry has become a true branch of progressive biology. It has opened up modes of thought about the physical basis of life which could scarcely be employed at all a generation ago. Such data and such modes of thought as it is now providing are pervasive, and must appear as aspects in all biological thought. Yet these aspects are, of course, only partial. Biology in all its aspects is showing rapid progress, and its bearing on human welfare is more and more evident.

Unfortunately, the nature of this new biological progress and its true significance is known to but a small section of the lay public. Few will doubt that popular interest in science is extending, but it is mainly confined to the more romantic aspects of modern astronomy and physics. That biological advances have made less impression is probably due to more than one circumstance, of which the chief, doubtless, is the neglect of biology in our educational system. The startling data of modern astronomy and physics, though of course only when presented in their most superficial aspects, find an easier approach to the uninformed mind than those of the new experimental biology can hope for. The primary concepts involved are paradoxically less familiar. Modern physical science, moreover, has been interpreted to the intelligent public by writers so brilliant that their books have had a great and stimulating influence.

Lord Russell once ventured on the statement that in passing from physics to biology one is conscious of a transition from the cosmic to the parochial, because from a cosmic point of view life is a very unimportant affair. Those who know that supposed parish well are convinced that it is rather a metropolis entitled to much more attention than it sometimes obtains from authors of guide-books to the universe. It may be small in extent, but is the seat of all the most significant events. In too many current publications, purporting to summarise scientific progress, biology is left out or receives but scant reference. Brilliant expositions of all that may be met in the region where modern science touches philosophy have directed thought straight from the implications of modern physics to the nature and structure of the human mind, and even to speculation concerning the mind of the Deity. Yet there are aspects of biological truth already known which are certainly germane to such discussions, and probably necessary for their adequacy.

VI

It is, however, because of its extreme importance to social progress that public ignorance of biology is especially to be regretted. Sir Henry Dale has remarked that "it is worth while to consider to-day whether the imposing achievements of physical science have not already, in the thought and interests of men at large, as well as in technical and industrial development, overshadowed in our educational and public policy those of biology to an extent which threatens a one-sided development of science itself and of the civilisation which we hope to see based on science." Sir Walter Fletcher, whose death during the past year has deprived the nation of an enlightened adviser, almost startled the public, I think, when he said in a national broadcast that "we can find safety and progress only in proportion as we bring into our methods of statecraft the guidance of biological truth". That statecraft, in its dignity, should be concerned with biological teaching, was a new idea to many listeners.

A few years ago the Cambridge philosopher, Dr. C. D. Broad, who is much better acquainted with scientific data than are many philosophers, remarked upon the misfortune involved in the unequal development of science ; the high degree of our control over inorganic Nature combined with relative ignorance of biology and psychology. At the close of a discussion as to the possibility of continued mental progress in the world, he summed up by saying that the possibility depends on our getting an adequate knowledge and control of life and mind before the combination of ignorance on these subjects with knowledge of physics and chemistry wrecks the whole social system. He closed with the somewhat startling words : "Which of the runners in this very interesting race will win it is impossible to foretell. But physics and death have a long start over psychology and life !" No one surely will wish for, or expect, a slowing in the pace of the first, but the quickening up in the latter which the last few decades have seen is a matter for high satisfaction. But, to repeat, the need for recognising biological truth as a necessary guide to individual conduct and no less to statecraft and social policy still needs emphasis to-day. With frank acceptance of the truth that his own nature is congruent with all those aspects of Nature at large which biology studies, combined with intelligent understanding of its teaching, man would escape from innumerable inhibitions due to past history and present ignorance, and equip himself for higher levels of endeavour and success.

Inadequate as at first sight it may seem when standing alone in support of so large a thesis, I must here be content to refer briefly to a single example of biological studies bearing upon human welfare. I will choose one which stands near to the general theme of my address. I mean the current studies of human and animal nutrition. During the last twenty years—that is, since it adopted the method of controlled experiment—the study of nutrition has shown that the needs of the body are much more complex than was earlier thought, and in particular that substances consumed in almost infinitesimal amounts may, each in its way, be as essential as those which form the bulk of any adequate dietary. This complexity in its demands will, after all, not surprise those who have in mind the complexity of events in the diverse living tissues of the body.

My earlier reference to vitamins, which had somewhat different bearings, was, I am sure, not necessary for a reminder of their nutritional importance. Owing to abundance of all kinds of advertisement, vitamins are discussed in the drawing-room as well as in the dining-room, and also, though not so much, in the nursery, while at present perhaps not enough in the kitchen. Unfortunately, among the uninformed their importance in nutrition is not always viewed with discrimination. Some seem to think nowadays that if the vitamin supply is secured the rest of the dietary may be left to chance, while others suppose that they are things so good that we cannot have too much of them. Needless to say, neither assumption is true. With regard to the second indeed it is desirable, now that vitamin concentrates are on the market and much advertised, to remember that excess of vitamin may be harmful. In the case of that labelled D at least we have definite evidence of this. Nevertheless, the claim that every known vitamin has highly important nutritional functions is supported by evidence which continues to grow. It is probable, but perhaps not yet certain, that the human body requires all that are known.

The importance of detail is no less in evidence when the demands of the body for a right mineral supply are considered. A proper balance among the salts which are consumed in quantity is here of prime importance, but that certain elements which ordinary foods contain in minute amounts are indispensable in such amounts is becoming sure. To take but a single example: the necessity of a trace of copper, which exercises somewhere in the body an indispensable catalytic influence on metabolism, is as essential in its way as much larger supplies of calcium, magnesium, potassium or iron. Those in close touch with experimental studies continually receive hints that factors still unknown contribute to normal nutrition, and those who deal with human dietaries from a scientific point of view know that an ideal diet cannot yet be defined.

This reference to nutritional studies is indeed mainly meant to affirm that the great attention they are receiving is fully justified. No one, I think, need be impressed with the argument that, because the human race has survived until now in complete ignorance of all such details, the knowledge being won must have academic interest alone. This line of argument is very old and never right.

One thing I am sure may be claimed for the growing enlightenment concerning human nutrition and the recent recognition of its study. It has already produced one line of evidence to show that nurture can assist nature to an extent not freely admitted a few years ago. That is a subject which I wish I could pursue. I cannot myself doubt that various lines of evidence, all of which should be profoundly welcome, are pointing in the same direction.

Allow me just one final reference to another field of nutritional studies. Their great economic importance in animal husbandry calls for full recognition. Just now agricultural authorities are becoming acutely aware of the call for a better control of the diseases of animals. Together these involve an immense economic loss to the farmers, and therefore to the country. Although, doubtless, its influence should not be exaggerated, faulty nutrition plays no small share in accounting for the incidence of some among these diseases, as researches carried out at the Rowett Institute in Aberdeen and elsewhere are demonstrating. There is much more of such work to be done with great profit.

VII

In every branch of science the activity of research has greatly increased during recent years. This all will have realised, but only those who are able to survey the situation closely can estimate the extent of that increase. It occurred to me at one time that an appraisement of research activities in Great Britain, and especially the organisation of State-aided research, might fittingly form a part of my address. The desire to illustrate the progress of my own subject led me away from that project. I gave some time to a survey, however, and came to the conclusion, among others, that from eight to ten individuals in the world are now engaged upon scientific investigations for every one so engaged twenty years ago. It must be remembered, of course, that not only has research endowment greatly increased in America and Europe, but also that Japan, China, and India have entered the field and are making contributions to science of real importance. It is sure that, whatever the consequences, the increase of scientific knowledge is at this time undergoing a positive acceleration.

Apropos, I find difficulty as to-day's occupant of this important scientific pulpit in avoiding some reference to impressive words spoken by my predecessor which are still echoed in thought, talk and print. In his wise and eloquent address at York, Sir Alfred Ewing reminded us with serious emphasis that the command of Nature has been put into man's hand before he knows how to command himself. Of the dangers involved in that indictment he warned us ; and we should remember that General Smuts also sounded the same note of warning in London.

Of science itself it is, of course, no indictment. It may be thought of rather as a warning signal to be placed on her road : "Dangerous Hill Ahead", perhaps, or "Turn Right" ; not, however, "Go Slow", for that advice science cannot follow. The indictment is of mankind. Recognition of the truth it contains cannot be absent from the minds of those whose labours are daily increasing mankind's command of Nature ; but it is due to them that the truth should be viewed in proper perspective. It is, after all, war, to which science has added terrors, and the fear of war, which alone give it real urgency ; an urgency which must of course be felt in these days when some nations at least are showing the spirit of selfish and dangerous nationalism. I may be wrong but it seems to me that, war apart, the gifts of science and invention have done little to increase opportunities for the display of the more serious of man's irrational impulses. The worst they do perhaps is to give to clever and predatory souls that keep within the law, the whole world for their depredations, instead of a parish or a country as of yore.

But Sir Alfred Ewing told us of "the disillusion with which, now standing aside, he watches the sweeping pageant of discovery and invention in which he used to make unbounded delight". I wish that one to whom applied science and Great Britain owe so much might have been spared such disillusion, for I suspect it gives him pain. I wonder whether, if he could have added to "An Engineer's Outlook" the outlook of a biologist, the disillusion would still be there. As one just now advocating the claims of biology, I would much like to know. It is sure, however, that the gifts of the engineer to humanity at large are immense enough to outweigh the assistance he may have given to the forces of destruction.

It may be claimed for biological science, in spite of vague references to bacterial warfare and the like, that it is not of its nature to aid destruction. What it may do towards making man as a whole more worthy of his inheritance has yet to be fully recognised. On this point I have said much. Of its service to his physical betterment there can be no doubts. I have made but bare reference in this address to the support that biological research gives to the art of medicine. I had thought to say much more of this, but found that if I said enough I could say nothing else.

There are two other great questions so much to the front just now that they tempt a final reference. I mean, of course, the paradox of poverty amidst plenty and the replacement of human labour by machinery. Applied science should take no blame for the former, but indeed claim credit unfairly lost. It is not within my capacity to say anything of value about the paradox and its cure ; but I confess that I see more present danger in the case of 'Money versus Man' than danger, present or future, in that of the 'Machine versus Man' !

With regard to the latter, it is surely right that those in touch with science should insist that the replacement of human labour will continue. Those who doubt this cannot realise the meaning of that positive acceleration in science, pure and applied, which now continues. No one can say what kind of equilibrium the distribution of leisure is fated to reach. In any event an optimistic view as to the probable effects of its increase may be justified.

It need not involve a revolutionary change if there is real planning for the future. Lord Melchett was surely right when some time ago he urged on the Upper House that present thought should be given to that future ; but I think few men of affairs seriously believe what is yet probable, that the replacement we are thinking of will impose a new structure upon society. This may well differ in some essentials from any of those alternative social forms of which the very names now raise antagonisms. I confess that if civilisation escapes its other perils I should fear little the final reign of the machine. We should not altogether forget the difference in use which can be made of real and ample leisure compared with that possible for very brief leisure associated with fatigue ; or the difference between compulsory toil and spontaneous work.

We have to picture, moreover, in Great Britain the reactions of a community which, save for a minority, has shown itself during recent years to be educable. I do not think it fanciful to believe that our highly efficient national broadcasting service, with the increased opportunities which the coming of short wave-length transmission may provide, might well take charge of the systematic education of adolescents after the personal influence of the schoolmaster has prepared them to profit by it. It would not be a technical education but an education for leisure. Listening to organised courses of instruction might at first be for the few; but ultimately might become habitual in that part of the community which it would specially benefit.

In parenthesis allow me a brief further reference to 'planning'. The word is much to the front just now, chiefly in relation with current enterprises. But there may be planning for more fundamental developments; for future adjustment to social reconstructions. In such planning the trained scientific mind must play its part. Its vision of the future may be very limited, but in respect of material progress and its probable consequences, science (I include all branches of knowledge to which the name applies) has at least better data for prophecy than other forms of knowledge.

It was long ago written, "Wisdom and Knowledge shall be stability of Thy times". Though statesmen may have wisdom adequate for the immediate and urgent problems with which it is their fate to deal, there should yet be a reservoir of synthesised and clarified knowledge on which they can draw. The technique which brings governments in contact with scientific knowledge in particular, though greatly improved of late, is still imperfect. In any case the politician is perforce concerned with the present rather than the future. I have recently read Bacon's "New Atlantis" afresh and have been thinking about his Solomon's House. We know that the rules for the functioning of that House were mistaken because the philosopher drew them up when in the mood of a Lord Chancellor; but in so far as the philosopher visualised therein an organisation of the best intellects bent on gathering knowledge for future practical services, his idea was a great one. When civilisation is in danger and society in transition, might there not be a House recruited from the best intellects in the country with functions similar (*mutatis mutandis*) to those of Bacon's fancy? A House devoid of politics, concerned rather with synthesising existing knowledge, with a sustained appraisement of the progress of knowledge, and continuously concerned with its bearing upon social readjustments. It is not to be pictured as composed of scientific authorities alone. It would be rather an intellectual exchange where thought would go ahead of immediate problems. I believe that the functions of such a House, in such days as ours, might well be real. Here I must leave them to your fancy, well aware that in the minds of many I may by this bare suggestion lose all reputation as a realist!

I will now hasten to my final words. Most of us have had a tendency in the past to fear the gift of leisure to the majority. To believe that it may be a great social benefit requires some mental readjustment, and a belief in the educability of the average man or woman. But if the political aspirations of the nations should grow sane, and the artificial economic problems of the world be solved, the combined and assured gifts of health, plenty, and leisure may prove to be the final justification of applied science. In a community advantaged by these, each individual will be free to develop his own innate powers, and, becoming more of an individual, will be less moved by those herd instincts which are always the major danger to the world.

It may be felt that, throughout this address, I have dwelt exclusively on the material benefits of science to the neglect of its cultural value. I would like to correct this in a single closing sentence. I believe that for those who cultivate it in a right and humble spirit, science is one of the humanities; no less.

Summaries of Addresses of Presidents of Sections*

Seasonal Weather Conditions and Forecasting

In his presidential address to Section A (Mathematical and Physical Sciences), Sir Gilbert Walker discusses the problem of "Seasonal Weather and its Prediction".

The demand for warning of the calamity due to a failure of the rains has in a number of countries been so great that it has produced a supply, often of the most doubtful quality. Modern methods do, from time to time, enable us to foresee a drought with considerable certainty; but appreciation and confidence will not be won unless those methods are discarded which will not bear scrutiny; further, the best methods as yet available yield only approximations, and it is only when their indications of an excess or a deficiency of rain are really emphatic that publication can be justified. Of unreliable methods, that in widest use is based on periodicities to which standard criteria have not been applied; the widespread instinctive faith in weather cycles is probably a survival from the days of astrology and magic.

The most satisfactory index as yet available for the seasonal rainfall of a region depends on success in discovering previous weather conditions, there or elsewhere, which exercise control over it. A search for such relationships over the world is facilitated by finding closely interrelated groups of seasonal conditions of pressure, temperature and rainfall. Such systems prevail in the North Atlantic and North Pacific Oceans; and there is a large system controlling the fluctuations over the Pacific and Indian Oceans, with the rainfall of southern Asia, part of South Africa, Australia and part of South America. A surprising persistence of conditions in this system in the southern winter yields at once rough indications of the character of the summer rainfall in several important southern areas, and these can be improved by a study of the local relationships.

Sir Gilbert then describes the systems of prediction now in use and the degree of success that they have reached. In India, during the past thirty years, the published estimates of future monsoon rainfall have on the average been right twice in three times; and it may be held that any programme leading to success less than four times in five is too ambitious. However, in Southern Rhodesia similar statistical methods have worked well; out of eight forecasts based on a clear indication seven have been correct. Short accounts are also given of the processes employed in Java, Australia, California, Sweden, Russia and Germany.

Towards the physical explanation of the world-wide oscillations, little progress has been made. The control appears to lie neither in sunspots nor in any short-lived solar emanation; nor in the amount of pack ice in the antarctic; nor in the temperature of the Pacific Ocean. But there is ample scope for inquiry with the view of improving existing methods; and investigations are needed regarding such large unstudied areas as exist in Asia, South America and Central Africa.

Natural Colouring Matters

Prof. R. Robinson in his presidential address to Section B (Chemistry) points out that the plant and animal pigments have excited the interest of chemists not only because of the intrinsic importance of these substances, for example, in the physiology of respiration, but also because the property of visible colour, more than any other, facilitates the experimental study of a compound. It happens that the study of colour in Nature has had the most important consequences often in totally unexpected directions.

The example of Baeyer's researches on indigo is well known, and similarly the investigations of Graebe and Liebermann on the molecular structure of the constituents of madder were the forerunners of the modern development of fast vat dyes derived from anthraquinone.

Other fundamental researches on colouring matters have been too numerous to catalogue, but special mention is made of A. G. Perkin's and von Kostanecki's studies of the yellow water-soluble plant colouring matters, of Willstätter's pioneering work on chlorophyll, the blood pigment and the anthocyanins, and of Hans Fischer's wonderful syntheses in the porphyrin group culminating in the artificial preparation of hæmin.

Prof. Robinson also directs attention to the analogies existing between the various classes of

* The collected presidential addresses delivered at Leicester are being published under the title "The Advancement of Science" (Leicester: B.A. Reception Room; London: Burlington House), price 3*s*. 6*d*.

natural colouring matters and the synthetic dyestuffs. Until recently the very characteristic porphyrins, the basic skeleton of the natural respiratory pigments, had no industrial analogues. Now, however, the phthalocyanines, in which nitrogen atoms replace some methine groups of the porphin units, furnish an appropriate parallel and this development is the subject of a paper contributed by Dr. R. P. Linstead.

Turning to a special section of the natural colouring matters, Prof. Robinson discusses some aspects of the study of the red and blue flower-colours and first pays a tribute to the brilliant work of Willstätter, who isolated a large number of these anthocyanins, crystallised them in the form of oxonium salts, and showed that the latter are saccharides or acylated saccharides of the nuclear anthocyanidins consisting of pelargonidin, cyanidin and delphinidin or various methyl ethers of the two latter. The proposed constitutions have been justified by syntheses of pelargonidin and cyanidin.

As the result of more recent work, all the anthocyanidins and the more important of the anthocyanins have been synthesised, and after giving a list of these pigments of ascertained constitution, Prof. Robinson shows (with the help of some simple experiments) how the possession of pure synthetic specimens has made possible a survey of anthocyanins not only in flowers but also in all other coloured parts of plants.

A further problem on which light can be thrown is that of the cause of colour variations in flowers. The most obvious is the nature, distribution and concentration of the colouring matters, and no elaboration of this is needed ; the wallflower and the viola are familiar illustrations of flowers which are coloured by pigments of more than one type.

Less simple is the case of the blue cornflower and the red rose, both of which are coloured by cyanin. Since the latter is blue in alkaline solution and red in acid solution it seemed clear at one time that the cell-sap of the cornflower should be on the alkaline side of the neutral point whereas the cell-sap of rose petals should be acid. Comparison of absorption spectra appeared to confirm this, but actual observation of the cell-sap of the cornflower shows that it is fairly strongly acid, and indeed its pH is lower than that of the red rose (also acid, however).

The explanation which has been advanced by Prof. and Mrs. Robinson is that in blue flowers (all of which so far examined have acid or nearly neutral cell-saps) the colouring matter is in colloidal solution and the particles bear a negative charge located or distributed on the oxygen atoms of the anthocyanin molecules. It is shown that cyanin may be dissolved in tap-water to a blue colloidal solution or to a violet solution according to the conditions employed, and the effect of starches and xylan as protective colloids can also be demonstrated. Thus the conditions obtaining in the blue cornflower with respect to the colouring matter can be simulated ; but only in part successfully, since the synthetic colloid is not so stable as the natural one.

Prof. Robinson also mentions the existence of substances termed co-pigments, of which the tannins and anthoxanthins are the chief known representatives. These compounds modify the colour of anthocyanins under all conditions likely to be found in a plant and even in the presence of an excess of mineral acid. The phenomenon is doubtless due to a species of chemical combination, and this is indicated by the large effect of co-pigments in modifying the distribution of anthocyanins between immiscible solvents.

Finally, the question of the influence of iron is briefly noticed, but the experimental evidence for the plausible view that the iron reaction is occasionally responsible for blue colours in flowers still rests solely on the practice of gardeners in the case of the culture of blue-flowered hydrangeas.

Geology of the Coal Measures

IN his address to Section C (Geology) on "A Correlation of Structures in the Coalfields of the Midland Province", Prof. W. G. Fearnsides directs attention to the wealth of three-dimensional information concerning beds of sediment, and the shape, size and distribution of folds and normal faults, which awaits interpretation in the Midland coalfields. He points out the value of exact knowledge of structure to those who plan the extension of mining in areas where coal measures lie concealed. He reviews the Carboniferous stratigraphy of the Midland province—a region naturally defined by the ring of nearmost outcrops of Lower Palæozoic rocks, and lying within a circle of sixty-mile radius centred near Buxton—to demonstrate that, almost to the end of the Upper Carboniferous period, the area was behaving as a unit geosynclinal trough. It was in this trough that the Midland coal measure sediments were accommodated, and after each of its many pulsations of regional depression it was filled brim-full with sediment on which successive coal seams grew. The amplitude of geosynclinal sinking is considered zone by zone, and it is noted that 12,000 ft. of deposits in the central area between Manchester and the Peak lose more than half their thickness within fifty miles in all the districts around. The wedging out becomes more rapid towards the edges of the basin.

Local variations of thicknesses of Coal Measures within the several separated coalfields are considered in their relations to local folds. In marginal areas the anticlines line up with Lower Palæozoic rock outcrops, and probably overlie ribs of structural reinforcement in the pre-Carboniferous floor. During the Productive Coal Measures period, less material was accumulated over the anticlines than in the intervening synclines, but only in the latest stages were certain upfolds in the west raised sufficiently to determine local unconformities. When, during the late Carboniferous–pre-Permian structural revolution, the central part of the geosynclinal was everted and upraised to form the asymmetric Peakland dome, the tightening of folds within the coalfields proceeded along the old-established lines. Prof. Fearnsides therefore concludes that the major structures within the Midland province are not superficial wrinklings produced by lateral thrust in the foreland of Hercynian Alps, but were formed by posthumous disturbances of their own deep-seated Charnian or Caledonian foundations.

Prof. Fearnsides discusses in detail the location and orientation of folds and faults within the Midland province as recorded by officers of the Geological Survey. Pantographic reductions from the published maps reveal no systematic intercrossings of major or minor flexures. Axial lines from all the southern Midlands between the Longmynd and Charnwood Forest converge as in a sheaf or bundle in the borders of Derbyshire and Cheshire, but open fan-wise across Lancashire and through Yorkshire, returning southwards to encircle the limestone outcrop of the High Peak of Derbyshire. It is shown that the commonly accepted application of the name 'Pennine' as a general description for north-south folds, and its limitation to post-Carboniferous structures which have that directional orientation, has no justification in the distribution of folds and faults in the Pennine area of the Midland province.

A consideration of the fault pattern as plotted leaves no illusion that fault direction in these coalfields can be accepted as a guide to relative age. Few fault lines are straight, and families of faults, though often their members anastomose, sometimes end abruptly where they meet. Important groups of faults occur *en echelon* in the middle limbs of folds, others reduce the effect of pitch in broader troughs. Such faults, all normal, are distinguished as longitudinal or tranverse to the coalfield folds, but it is recognised that there is need, as there is opportunity, for critical examination of mine plans to prove exactly the geometry of this structural relationship. The occurrence of extensive arcuate groups of faults is noted. Some seem to encircle, closely or at a distance, the broad areas of Trias-filled depressions : others sweep round the area of maximum post-Carboniferous regional uplift. Both series break across the local Carboniferous foldings, and have continued their movement later than the characteristic coalfield faults.

Mechanism in Biology

In his presidential address before Section D (Zoology) Dr. J. Gray discusses "The Mechanical View of Life". The laws which physics has provided for an analysis of biological phenomena rest on a statistical basis ; they only apply to systems which contain a large number of participating units and only describe natural phenomena in terms of probability and not of absolute truth. If we accept these laws as a means of describing the behaviour or the structure of an organism, we must accept the conventions attached to the laws and agree to ignore such events as are improbable, although they may conceivably occur.

From this point of view, the spontaneous origin of living from inanimate matter must be regarded as a highly improbable event, and as such can be assumed not to have occurred. It has been suggested that in past ages events which are now very improbable occurred with tolerable frequency ; but if biological science is to rest on observed facts, we cannot accept this suggestion without some indication of the conditions which had such a profound effect on the behaviour of molecular systems. It would be unfortunate if the standard of probability accepted in biology were incomparably less satisfying than those of other branches of knowledge.

The development of an organism from so-called undifferentiated protoplasm involves processes which are without parallel in inanimate Nature, and there is evidence to support the view that the characteristic power of an organism to produce dynamic systems of high complexity is present in units of extremely small dimensions.

In the present state of our knowledge, the intrinsic properties of 'living' matter are as mysterious and as fundamental as those of an inanimate atom or electron, and it seems more logical to accept these properties as fundamental concepts than to assume prematurely that they can be defined in terms of purely physical laws. Certain properties are common to matter in the living and in the non-living state, and the study of these properties has led to a much deeper understanding of many of the activities of living cells or animals. The intrinsic potentiality of living matter has, however, no physical parallel, and for its study biology must be the mistress and not the servant of the physical sciences; she must make her own foundations and not attempt to force the wine of life into bottles designed for use in the simpler fields of chemical science.

Cultural Aspects of Geography

LORD MESTON in his presidential address to Section E (Geography), entitled "Geography as Mental Equipment", dwells on the cultural side of geography. While geography is a synthetic science, a function of a number of sciences, it is not imperative that the ordinary man should be a skilled astronomer, geologist or historian in order that geography should offer him a vast field of intelligent interest.

To many there is a particular attraction in that remote corner of the field where geography stands disclosed as a science, not of immutable, but of changing data, the changes of catastrophes of the past—carrying the fancy back into the Tertiary Age, or to the conditions in which human races were evolved and migrated over the face of the earth. To many lay students of geography the visible and superficial changes, as opposed to the vaster geological movements, in the face of Nature have a particular attraction, involving research in climatology, meteorology, oceanography and so on. Another aspect of geography is that side of it which is concerned with history—political geography. Geography and economics have shaped history, and without some knowledge of them our study of history is liable to be both arid and misleading.

If we turn to physical geography, we are thinking mainly of how the forces of Nature can be observed and calculated in their action upon the habitable globe, how they make it more or less endurable for human beings. Here a plea is entered for the older exponents of environmental influence, such as Bodin and Buckle, especially for the telling patches of colour in the latter. Is there not wide scope for investigating the part geography plays at first in shaping religions and afterwards in maintaining morals? The contrast between Greece and India is full of suggestion; while in connexion with two other great religions, Judaism and Islam, is it altogether fanciful to surmise that geography has been directly concerned in their development?

Human geography on its material and practical side studies nothing less than the eternal struggle of Nature versus man, as for example the Alpine barrier affected the relations of Italy and Central Europe, and the Appalachian barrier for long determined the range of colonisation in North America. The chief purpose of human geography is to record how these forces are arrayed to-day: what are the natural resources of the country, how are its industries geographically conditioned, what are the conditions of labour and transport.

Geography's relation with economics is as intimate as it is with geology, while in the study of movements of population, changes in industry affecting the employment of labour, and competition for the world's markets, geography may be a useful agency from the point of view of international peace. The whole purport of the address is a plea for greater attention to geography, and a more scientific method of teaching it in our educational system generally and in our elementary and secondary schools particularly.

The Gold Standard

IN his presidential address to Section F (Economics and Statistics), Prof. J. H. Jones discusses the problem of the gold standard. He points out that the economic conditions under which the post-War gold standard was called upon to work differed materially from those which had enabled the pre-War standard to enjoy so large a measure of success, that it was taken for granted as an integral part of the modern economic system.

First, the pre-War standard was of slow growth and the economic conditions of each country were adapted to its requirements. The wage, cost and internal price levels were adjusted to the necessity for supplying goods and services at the international price level. Currency was neutral in the sense that the currency standard favoured the distribution of international trade in the manner determined by real costs of production.

Secondly, the savings of the people were normally invested in long-term securities. Thirdly, the long-term foreign investments of lending countries were appropriate to the industrial structures of both lending and borrowing countries. Fourthly, protection as a policy was adopted on presumed long-term economic considerations ; it was more or less a constant and for that reason did not endanger the working of the gold standard. Finally, the credit system was highly organised. When need arose, the Bank of England was able to mobilise the resources of stronger countries and to place them at the disposal of necessitous countries. Credit operations thus acted as a balancing influence.

The post-War situation differed from the pre-War situation in all these respects. Most countries rushed back to the gold standard without seeking to adjust the gold values of their respective currencies to domestic cost and price levels. Some currencies were over-valued, others under-valued. Savings were held within call, being placed in the countries that appeared to offer security. At the first sign of danger they were withdrawn, leaving crisis in their train. Where credit operations once maintained or restored equilibrium they now destroyed equilibrium. The War also changed the financial relationships of States ; debtors became creditors and creditors became debtors, with the result that the industrial structures of countries were not appropriate to their financial relations with the rest of the world. Tariffs and other *ad hoc* restrictions were employed in the endeavour to remove adverse trade balances which were formerly covered by credit operations.

Prof. Jones considers that while such conditions exist it would be unwise to restore the gold standard. On the other hand, he believes that when the world has emerged from the crisis and confidence has returned, it would be desirable to return to gold, under appropriate conditions. The real alternative to an international (gold) standard is a system of national currencies, such as those now in existence in many countries. The advocates of this alternative stress the need for internal price stability, but Prof. Jones holds the view that even such stability is more likely to be maintained under the gold standard than under a national system, in the working of which price stability is the objective. Even under favourable conditions it is extremely likely that national currency systems, which are not linked together by being linked to gold, will produce the kind of price disequilibrium from which the world is suffering.

Advancement of Mechanical Engineering

Describing mechanical engineering as that branch of engineering which deals with the invention, design, construction, installation and operation of machinery by means of which the forces of Nature are harnessed and applied for the service of mankind, Mr. R. W. Allen, in his address to Section G (Engineering) draws mainly on his own wide experience.

It was the great pioneering labours of Sir Charles Parsons which laid the main foundations for the turbine design of to-day. Through the invention of the compound steam turbine, the condensing turbine and the geared turbine the machinery for ships and power houses has come. For marine work single turbines of 50,000 s.h.p. have been constructed, while the geared turbine has been applied to many purposes on shore, including the driving of continuous current dynamos up to 3,000 k.w. There are many examples of large turbine plants with a thermal efficiency of nearly 30 per cent, and turbo-generators developing 200,000 k.w. have been built for power houses.

The development of the oil engine is another feature of cardinal importance in recent engineering history. Diesel's famous patent was taken out only forty-one years ago. It was his intention to burn coal direct in the working cylinder, but this was found impracticable owing to the large amount of unburnt residue. It may be, however, that a satisfactory internal combustion engine, utilising powdered coal as fuel, will be one of the developments of the future. One of the difficult problems in connexion with the development of the Diesel engine was the air compressor, but the use of mechanical injection as introduced first by Akroyd Stuart removed the disadvantages associated with high-pressure air ; and dispensing with the compressor driven from the crankshaft led to improved engine balance, and a reduction in the size and weight of engines. There is, Mr. Allen said, boundless scope for the application of the Diesel engine ; the high-speed Diesel engine of small size and low weight is particularly suitable for traction.

The centrifugal pump, like the turbine and oil engine, has also been greatly improved in recent times. Its design is now a highly specialised study, and characteristics can be forecast, for numerous combinations of conditions, with a reasonable degree of accuracy. Compared with the plunger type, the centrifugal pump has the advantages of much lower capital and maintenance costs, with concomitant economy in space and weight. A striking application of this pump has been in the handling of coal, sands, gravels, and the like, where in spite of the abrasive nature of the materials, maintenance costs can be kept comparatively low. Lined pumps of special construction are capable of passing stones and boulders up to the size of the delivery branch. Centrifugal pumps are now being used in waterworks installations, graving and floating docks, the reclamation of waste lands, irrigation and mining.

Many things have contributed to the advancement of mechanical engineering. Among these are the abandonment of the 'rule-of-thumb' methods and the substitution of scientific methods, the extension of research and the introduction of standardisation. Special tributes are due to the staff of the National Physical Laboratory and to the British Standards Institution and also to the invaluable services rendered by the technical press.

Mr. Allen also discusses the training of the engineer.

Tradition in Anthropology

In his presidential address before Section H (Anthropology), entitled "What is Tradition?", Lord Raglan states that tradition is "anything that is handed down orally from age to age". It includes methods of farming, of craftsmanship, of preparing food, of dealing with property, as well as birth, marriage and death customs, etiquette, superstitions, games, sports, songs and dances, and, lastly, traditional narratives. With the apparent exception of the last item, tradition forms a code of rules which cover every aspect of savage, and most aspects of civilised, life.

The traditional narrative, to which the rest of the address is devoted, takes various forms, such as the myth, legend, epic poem, ballad, saga and fairy tale. It has usually been divided into two classes, the supposedly historical and the supposedly fictitious.

The theory that some traditional narratives are historical is based on the supposition that illiterate people take an intense interest in historical fact, and regard its preservation as of the utmost importance. This supposition is against all the known facts. Not only do illiterate people take no interest in historical facts, but they could not transmit them if they wished to ; hearsay evidence is rightly rejected in our courts because of its notorious unreliability ; why should a fact which cannot be transmitted orally the length of a street be supposed capable of oral transmission through many centuries ?

Some types of traditional narrative are supposed to be the result of the imagination of story-tellers, but there is abundant evidence that story-tellers are merely repeaters ; illiterate people neither transmit facts nor invent fables.

All traditional narratives are, or once were, like all other traditions, rules ; rules for the performance of rites or ritual dramas. These *must* be remembered, since on their correct performance depends the prosperity of the community, and *can* be remembered and transmitted, since they are performed repeatedly in the presence of the whole community.

After disposing of two forms of pseudo-tradition, the 'family tradition' and the 'local tradition', Lord Raglan takes, as a crucial case, the traditions about Henry V, which were adopted by Shakespeare. If any quasi-historical traditions can be true these should be, yet they are demonstrably false in every particular. When the names of historical characters appear in tradition, they are merely pegs upon which to hang ancient traditional tales.

In various parts of the world there is still a close connexion between myth and ritual, and the ritual drama has played a most important part in the religious life of nearly every people. An English example is Robin Hood, King of May. There is no doubt that he is a purely mythical character, that is to say, a character in a ritual drama. The same applies to William Tell.

After dealing with the supposedly historical character of the Icelandic sagas and the Polynesian traditions, Lord Raglan concludes by pointing out the features by which the traditional narrative betrays its origin in the ritual drama—it is always dramatic ; the characters always speak the same language ; the action is often carried on by songs ; there is much conversation ; costume is described ; there is often a conventional setting ; miraculous lapses of time occur; the characters remain the same age; they are all contemporaries; supernatural beings are always personified; shape-changing is common; kings and queens always appear; battles consist of single combats; prophecies always come true; there is usually a character who directs the action.

The belief in the historicity of the traditional narrative is a survival from the pre-scientific age, one of a number of such survivals the existence of which prevents social anthropology from taking what should be its proper place among the sciences.

Activities of Nerve Cells

In his presidential address to Section I (Physiology), Prof. E. D. Adrian discusses the central nervous system and the prospect of giving a satisfactory explanation of its activities. To the majority of physiologists a satisfactory explanation must be one which shows how the individual cells of the nervous system combine to direct the behaviour of the organism.

From one point of view the prospects are encouraging. The neurones, or units of the nervous system, are built up on an elaborate plan, but experimental embryology has begun to determine the forces which mould the developing cells and direct the long threads of protoplasm which grow out from them to form the nerve fibres. Work on other lines has shown that in their main reactions the neurones do not differ greatly from other kinds of excitable cell. The rapid transmission of signals over long distances is carried out in a simple way by trains of brief impulses passing along the nerve fibres. The impulses are set up in the sense organs and other specialised parts of the neurone, but similar trains of impulses can be set up in muscle fibres and their production seems to depend in both cases on the same kind of rhythmic breakdown and repair of a polarised surface.

Recent investigations of the electric changes in the cerebral cortex and in nerve ganglia show that in the grey matter these surface changes may have much slower and less uniform time relations. There are, however, many intermediate stages between the rhythmic succession of impulses in a nerve fibre and the slower and more irregular oscillations in the brain cortex.

The difficulties begin when we turn from the units to consider the nervous system as a whole. The simple diagrams of nerve centres and of pathways canalised by use can no longer be accepted. They have failed to explain the facts of habit formation and the rapid return of function after injury. Localisation of function certainly exists in the brain, but it is a matter of large areas rather than of small cell groups. A particular relation of sensory stimuli leads to a particular movement of the organism, and the relation is recognised and the movement achieved without much regard to the nerve tracts employed in forming the association. The importance, in learning, of the total mass of the cortex and the unimportance of particular regions is another example of this unified action of the brain.

To account for it should not be beyond the range of experiment, for there are many cases in which it is possible to study the action of smaller groups of nerve cells. The electric changes taking place in such groups and in the cerebral cortex show that the different neurones often pulsate synchronously, as though they formed a mass through which the waves of activity are freely conducted. In such a mass the waves due to incoming signals and to the spontaneous activity of nerve cells may produce nodes of vibration and interference figures, patterns in time as well as in space. Such patterns might be independent of precise neurone connexions. It is possible that they may supply the basis for an appropriate motor response, though how they can do so is a problem to which no answer can be given in the present state of our knowledge.

At the moment no one would claim that we have a satisfactory picture of the mechanisms at work in the brain. It may be that such a picture is unattainable; but at least we have new problems and the prospect of fresh data in a most interesting field.

Empirical Basis of Psychology

In his presidential address to Section J (Psychology), entitled "The Status of Psychology as an Empirical Science", Prof. F. Aveling develops the theme that psychology is the most radically empirical of all the sciences because it is concerned with the totality of immediate experience rather than with remote inferences from selected parts of sensory experience, as are all the other natural sciences.

To establish this contention, a distinction is first drawn between several meanings of the term 'empirical'. A science is said to be empirical if its data depend upon the evidence of our senses; though obviously it goes beyond such data in its systematic constructions, in which it makes use of explanatory concepts that are not discoverable within the data in question. For example, the ordinary explanatory concept of cause, and the scientific concept of quantitative equivalence, are not to be found within the sensory data of any observed phenomenal sequence.

A science may also be said to be empirical, however, if it is constructed from the data of experience of whatever kind, sensory or otherwise; and in the totality of our experiences we are able to discover those from which the explanatory concepts used in its own systematic constructions, as well as in those of the other sciences, are immediately educed.

Such a science is psychology, in which not only are all experiences studied in their own right and at their face value, but also all explanatory concepts are traced to their origin. This clearly means that such concepts, directly derived from one field of experience, are applied in another field. In this way, concepts immediately educed from self-experience have been and are used in physical and biological science to interpret and explain objectively observed phenomena.

After a brief examination of the data of science in general, and a consideration of the methods of structural and functional analysis as practised in systematic scientific constructions, a more detailed historical analysis of the explanatory concept of causality is made. In this analysis it is shown how a progressive de-anthropomorphisation of physical and biological science has come about, in which, one after the other, concepts of causation, originally invoked to explain change or becoming, have been rejected, until we are left with that of quantitative equivalence between antecedent and consequent phenomena, or even only with mathematical equations. It is further shown how, at every step in the refinement of the concept as applied in the explanation of physical change, some self-experience is retained. For the concepts of thinghood, identity and unity are involved in all forms of the explanatory concept of causality; and the experience of thing, identical thing and unitary thing is, and uniquely is, an experience of self. It is, accordingly, from this experience that the concept is derived. Furthermore, the concept of energy, which has not yet been entirely rejected by science, is to be traced to the same source, the unitary, self-identical self, actualising or energising in the various ways of perceiving, recalling, judging, desiring, enjoying, and the like.

The foregoing leads directly to a consideration of the validity of the principles and postulates of physical science, the relevance of some of which is taken for granted, even when they are applied to mental events. It is maintained that none of these principles, since all have immediately or mediately been derived from self-experience, should be allowed to displace or contradict the very experiences in virtue of which they have been made possible of formulation.

Finally, the psychological processes by which the concepts and inferences alike of science are reached are indicated.

Entrance Mechanisms of the Traps of *Utricularia*

It is only within the last few years that we have attained an adequate understanding of the way in which the trap (or bladder) of *Utricularia* works in the catching of prey. It was shown in 1929 that the watertightness of the trap and the emplacement of the edge of the valve or door had not been properly explained. It is now recognised that the free door edge articulates with the threshold in such fashion that no ordinary pressure of water alone, to which it is normally subjected, can press it inwardly. It was already known from the work of Brocher, Withycombe, Merl and Czaja that such water pressures are always present, and are highest when the trap is in the set condition, that is, there is a lower pressure within than outside of the trap, and that this is the result of the physiological activity of the walls of the trap.

That such pressure is maintained at a constant level can only be due to the watertightness of the door and to its rigidity of articulation, procuring an "unstable equilibrium" as Brocher first called it. Its rigidity of position depends on the fact that the free door edge rests against an outwardly facing ridge or surface which effectively prevents its inswing, while the watertightness is achieved by the sealing of the articulation by a membrane, the velum, originating by the exfoliation of the collective cuticles of the threshold. The species studied were chiefly *U. vulgaris* and *U. gibba aff.* In Prof. F. E. Lloyd's presidential address to Section K (Botany), he describes the results of the examination of seventy-five other species of the genus, for the purpose of determining their mode of action in comparison with the above-mentioned species.

It may now be stated that the mechanical principles underlying the activity of the trap are the same for all species so far studied, that is, the unstable equilibrium of the set trap is procured in the same way in all; but there is an unexpected variety of form and detail of structure demanding specific explanations for several different groups of species. To cite one character, namely, the mechanism by which the door is thrown out of symmetry, thereby allowing the inpressing water to push in the door. This may consist of the latch lever made up of stiff bristles attached to the surface of the door in such fashion that impact of prey, such as a daphnid, against them may so disturb the emplacement of the door edge that the water can now press it in, which occurs at a very high rate of speed (a thirty-fifth of a second). At the other extreme there is to be found no tripping mechanism at all, the prey having to cause a small dent in the door surface, when its effective resistance to the water pressure is destroyed. Between these extremes is a variety of mechanisms which cannot be regarded as intergradations and do not fall into a series. Nor do they appear to be more or less efficient, because of their differences of structure.

Again, the velum displays a variety of structure correlated with certain characters of the door in its relation to the threshold. It is here a question of angular divergence of these two parts. If the angular divergence is high, the velum is a single compact valvular membrane ; if low, the velum is more extensive, with much greater fore and aft dimensions. In one small group of species there is a secondary as well as the primary set of membranes, while in some Australasian species this secondary velum is a circular valve. Add to these varieties of structure thus briefly exemplified, variety in similar extent of all the other structures, and it may be appreciated that the trap of *Utricularia* is even bizarre in its complexities.

Development of the National System of Education

SECTION L (Educational Science) was established during the discussions which immediately preceded the passing of the Act of 1902 and the foundation of the present organisation of education under local authorities in partnership with the central authority—the Board of Education. That system is now undergoing the exacting re-valuation by the community which all departments of the national life have to face in times of crisis.

Mr. J. L. Holland, in his presidential address, reviews the major educational developments of the last thirty years and claims that the local authorities deserve well of the State for the use they have made of their opportunities. He contrasts the difficulty of organising education under a democracy, due to the many demands which have to be reconciled, with the simplicity of the like task under other forms of government ; instructed and consistent public support is a necessary condition of efficiency and progress in any democratic system. The main object of such a system must be to promote the free development of individual character and ability, and it is both wrong and futile to expect that the young will be trained merely to meet the social and economic needs of the day. In a changing society, moral courage, adaptability and resourcefulness will always be primary requirements.

The great development of secondary education has, in Mr. Holland's opinion, reached its limit. The secondary schools are no longer the schools of a class. They have, however, turned toward professional and clerical occupations numbers of young people of practical ability whose desertion is being keenly felt by industry and commerce. In the immediate future, boys and girls of this type should be encouraged to find their way to industry through the new senior or modern schools which are being rapidly established. These schools should soon attract much of the public support which has hitherto been given so unreservedly to the secondary schools.

The present position of education for industry and commerce, and the reasons why it is so largely a post-employment and part-time education, are discussed. There should be close association of employers and employees with the local authority in responsibility for this form of education, and regional co-ordination of higher technical instruction. At the same time, it is not to be expected that the community will accept that horizontal stratification of society on which the graded technical schools of other countries are based : the individual must still be free to strive for advancement, and education must assist him.

In his concluding section, Mr. Holland deals with the serious problem of the unemployed juveniles, whose numbers are now formidable. It is an educational problem, yet official education has scarcely more than touched the fringe of it. The duty of dealing with it should be placed upon the local education authorities. Juveniles should be advised to remain at school until situations can be found for them. The age of compulsory insurance should be lowered to fourteen years and credit should be given against the Unemployment Fund for school attendance beyond that age, as recommended by the recent Royal Commission. The scheme procedure of Mr. Fisher's Act of 1918 should be adopted, local authorities submitting area schemes to the Board of Education, and receiving the grants in aid through the Board. But the fundamental need is that the national conscience should be aroused to the gravity of the position: a society awake to the de-civilising influence which enforced idleness must have upon this large section of its future citizens could not tolerate a half-hearted handling of the evil.

Chemistry and Agriculture

Dr. A. LAUDER in his presidential address to Section M (Agriculture) reviews the progress of agricultural chemistry since Sir J. H. Gilbert addressed Section B (Chemistry) of the Association on the same subject in 1880.

A critical survey of the modern views on the constitution of the soil, and of the methods employed in soil surveying and in soil analysis, is given, as well as an account of recent developments in the manufacture and use of fertilisers.

The important progress made in biochemistry in the last twenty-five years and the light this fuller knowledge throws on problems of animal nutrition and disease are discussed in detail.

In the concluding section of his address, Dr. Lauder deals with certain aspects of agricultural development and in particular with the suggestion that the application of science to agriculture is one of the causes of the prevailing agricultural depression. This is shown not to be the case, and it is pointed out that whatever opinion may be held as to over- or under-production of agricultural produce in the world as a whole, this much at any rate is clear; that an increased production of home-grown food is of paramount importance to Great Britain. Since the War, many industries have either disappeared or been greatly reduced in importance, and it is practically certain that there is going to be a permanent displacement of labour in certain trades. There is no better way of using this displaced labour than to employ it on the land to increase home agricultural production. It is unnecessary to point out or minimise the obstacles to so profound a change—the disinclination of an urban population to move to the country, the problems of housing and wages, and the necessity of obtaining a remunerative price for the food produced, being only some of the more obvious difficulties involved.

Dr. Lauder states that it is most important to supply the consumer with as large a proportion as possible of fresh food which has not been subjected to chilling or freezing or to any of the chemical manipulations or treatment which are much too common nowadays. The aim of the home producer should be to produce the type of food in largest quantity where this quality of freshness is of the highest importance, for example, meat, milk, butter, eggs, poultry and market-garden produce and fruit. In this way he could best meet the menace of overseas competition. At the same time much work would require to be done to educate the consumer to appreciate the superior value of fresh home-grown food as against that which has been chilled or preserved.

The modern farmer must now choose between two courses. He might either adhere to traditional systems under which his products have to meet those of overseas competitors who possess dominant advantages in the production of most of their crops, or, on the other hand, he might alter his system to meet the new conditions and produce those commodities which will command an unassailable position in the home market.

This alteration in the system of farming would mean many important changes; more concentrated foods would have to be grown, for example, beans and peas, and less concentrated foods imported. In this connexion, the highly nutritive quality of young grass and the methods for its utilisation should receive more attention; the growing of hay on a quality basis and the adequate use of silage should also be mentioned.

In conclusion, Dr. Lauder points out that the importance of agriculture, not merely as a means of producing additional home-grown food, but as an industry of fundamental social value, is now being realised by all sections of the community.

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

sodium a yellow light, and nitrogen a buff colour. The earlier experimental types of discharge lamp were developed for the efficient production of coloured light and are available to-day for decorative purposes, but efforts have been made, with considerable success, to produce lamps which give white light or light approaching white in colour. Development is continuing at a rapid rate, and the experimental lamps of to-day will, in all probability, be the practical lamps of to-morrow. Mr. Wilson gave technical details of the lamps which have actually been in successful use in outdoor installations. They give from two to three times the light of an ordinary electric lamp for the same current and enjoy a longer life. Practical installations have been erected at Croydon, Wembley and elsewhere, and these have shown that the new lamp can be applied successfully to public lighting. A high degree of visibility is attained, and objects on the roadway can be clearly seen for an unusually long distance.

Safety in Mines

THE Safety in Mines Research Board has issued its eleventh annual report for the year 1932. As usual it contains a very complete summary of the work of the Board, and it is becoming more and more obvious that this work is bearing fruit, whilst the prospects that results in the future will be even more important than those shown up to date are very promising. For example, the work that Mr. D. W. Phillips has been carrying on in determining the properties of coal measure strata, is not by itself of any direct importance as regards increasing the safety of the coal miner, but the data which he has obtained will certainly be utilised for that purpose. There is practically no aspect of coal-mining work which is not under investigation, and especially the study of the properties of wire ropes may be expected to yield important results, though as a matter of fact but few accidents have been traced to the failures of such ropes in use. It should also be put on record that throughout the country researches in the prevention of falls of ground are being carried out by a number of different committees of the various professional institutions interested in mining in the different districts, most of whom have appointed investigators, who are being paid by funds provided through the Safety in Mines Research Board. The money is, as a matter of fact, provided by the Miners' Welfare Fund Committee out of grants from the Miners' Welfare Fund, and the annual outlay of the Board, about £60,000, may fairly be said to be very usefully expended.

Burglary at the Geological Survey and Museum

THE burglary that took place at the Geological Survey and Museum, Jermyn Street, London, S.W.1, on Friday, August 25, was fortunately not so serious as would appear from some of the accounts in the press. A small case was forced open during the night, and about one-half of its contents abstracted. These comprised a colour-set of cut tourmalines, a handsome piece of rough beryl, a few cut sapphires showing colour variation, a set of cut blue and yellow zircons, and a few specimens of diamond-bearing and auriferous concentrates. Several large and valuable specimens were left in disorder in the case and it seems clear that the burglar was disturbed by the night-warder on patrol. The building at Jermyn Street is crowded with scaffolding to support the roof, and very special precautions have to be taken against the risk of fire. The condition of the building has increased the difficulties under which the night-watching of the Museum is carried out.

The Value of Birds

THE Royal Society for the Protection of Birds has just added four new colour charts—barn-owl, dipper, lapwing, cuckoo—to its attractive series of bird food charts. These show, pictorially, the bird referred to in the particular chart, and, graphically, the proportions of its food material, in three categories, showing activities beneficial to man, neutral, and harmful to man. It is noteworthy that of the four birds selected for the present issue, three do no harm whatever. The charts are 9 inches by 6 inches, charming in themselves, and we can imagine no better way of impressing upon children the services rendered by birds, than by exhibiting the charts (which now number a dozen) upon the class-room wall. But for the sake of scientific precision, it should be stated that the percentages of mice, weed-seeds, etc., are percentages by volume and not by number.

Announcements

AT a meeting of the International Federation of Eugenic Organisations to be held at the Royal College of Surgeons, Lincolns Inn Fields, London, on September 28 at 8, Prof. Hans Maier will read a paper (in French) on "Some Aspects of Sterilisation in Switzerland". Prof. Maier is director of the Zurich Mental Hospital, Burgholzli, where the history of these operations dates back many years and which is now one of the most active centres of sterilisation in Switzerland. Anyone interested is welcome; there will be an opportunity for discussion. Further information can be obtained from the Secretary, International Federation of Eugenic Organisations, 443 Fulham Road, London, S.W.10.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in civil engineering at University College, Nottingham—The Registrar (Sept. 16). A lecturer in applied mathematics at Acton Technical College, High Street, Acton, London, W.3—The Principal (Sept. 16). A teacher of chemistry and physics at Dartford Technical College—Mr. F. L. Notley, 15, Lowfield Street, Dartford (Sept. 18). An engineer sub-lieutenant in the Royal Indian Marine—The Secretary, Military Department, India Office, London, S.W.1 (Sept. 23). A municipal engineer for the Municipality of Haifa, Palestine—Crown Agents for the Colonies, 4, Millbank, Westminster, London, S.W.1 (Sept. 30). An agricultural bacteriologist in the Punjab Agricultural Service—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (Oct. 7).

Letters to the Editor

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

The Expanding Universe

IT is generally assumed that the observed red shift in the spectra of distant nebulæ is evidence of velocities of recession and not due to loss of energy in the photon with time. The speed of recession is found to increase in proportion to the distance of the nebulæ at a rate of 550 kilometres per second per megaparsec (1 megaparsec = 3·26 million light years) and, as the law of general uniform expansion is that every object recedes at a rate proportional to its distance, this is taken as direct observational evidence of a general uniform expansion of the universe. But, in reaching this conclusion, the assumption is made that the nebulæ have been moving with the same velocities for at least 150 million years. Light that left a faint nebula in Gemini 150 million years ago tells us that it was receding from us then at 25,000 kilometres per second, but is it necessarily receding at that rate now ? Our observations on nebular velocities extend over a long time range. Is it not possible to assume that the variations in observed velocities are variations with time and not with distance ? Assuming constant nebular velocities, the relation between distance and velocity is given approximately in the following table :

Distance in million light years.	Velocity of recession in kilometres per sec.
3·26	550
50·00	8500
100·00	17000
150·00	25000

If we interpret these measurements as variations of nebular velocity with time, we find that 150 million years ago we measured the radial velocity of a distant nebula and found it to be receding at a rate of 25,000 kilometres a second. Other distant nebulæ, observed 100 million years ago, were found to be receding at 17,000 kilometres a second. Nebulæ measured 50 million years ago were receding at 8,500 kilometres a second and those measured 3 million years ago at 550 kilometres a second. Five of our nearest neighbours, on which we have made observations within the last million years, seem to be moving towards us.

These are the facts observed. Do they necessarily support the theory of an expanding universe ? Is it not possible to interpret these results as evidence for velocities of recession that have been steadily decreasing and have been brought to zero within the last million years ? If a periodic universe is postulated, could we not take these velocities as evidence that a period of decreasing expansion is just behind us and a period of condensation about to begin ? Or, if the universe began explosively, as advocated by some recent theories, and all matter was projected with a radial motion greater than the present rate of recession of the nebulæ, can we not assume that we have been observing, during the last 150 million years, a slowing down of the initial velocities under the action of a cosmical attraction, rather than an increasing rate of expansion as a result of cosmical repulsion ?

These questions may have been asked, but I have not been able to discover the answer. One is given a choice of static or non-static solutions of Einstein's equations, and the non-static solutions seem capable of accounting for expanding, contracting or periodic universes. With theories so conveniently fluid, and with the idea of a universe expanding at an increasing rate so difficult to imagine, one would like to know if there is any insuperable objection to the interpretation of nebular velocities here outlined.

JANET H. CLARK.

Johns Hopkins University,
Baltimore.

I THINK everyone will agree with Miss Clark that if the distribution of nebular velocities is considered to be mainly a distance effect, it indicates an expanding system, whereas if it is mainly a time effect it indicates a system which is about to enter on a stage of contraction ; and her letter is of service in pointing out the two alternatives. Adopting the hypothesis that it is a time effect, we see from her figures that 100 million years ago the spiral nebulæ (near and far) were moving away from our galaxy at 17,000 km. per sec., and that in the next 50 million years some kind of central attraction acting equally on near and distant nebulæ reduced the recession to 8,500 km. per sec. Formally there is nothing against this ; but there is not much temptation to pursue the speculation unless some kind of cosmogonic explanation of the rather odd distribution of velocities and rather unusual law of attraction is offered. The most direct criticism is that the attractive force seems to be very much too large to be due to the ordinary gravitation of the system and has to be invented *ad hoc*.

My own point of view has been that the distribution of nebular motions *taken by itself* is a phenomenon which would admit of an almost unlimited number of cosmogonic interpretations ; and I have no objection to admitting yet another. Some of the interpretations offered seem to me to lack plausibility, but I have long since found that there is no accounting for tastes in such a matter. The position is quite different for those of us who approach the phenomenon by way of pure physical theory. Independently of any astronomical observations, we are more or less convinced of the existence of cosmical repulsion as a necessary consequence of the relativity of our measurements ; and I think it is now clear that the magnitude of the repulsive force can be calculated, though it may be some time before the formulæ are definitely settled.

We turn to the observations of the spiral nebulæ in the hope that the effect of the calculated force will be there clearly shown. There is, of course, always the chance that the effect may be masked by forces that we as yet know nothing of, or by a peculiar initial projection of the nebulæ the effect of which has not yet died down ; but at present the indications are that no such complication occurs. Those who think it premature to decide whether the recession of the nebulæ is a clue to the structure of protons and electrons or a cosmogonic puzzle with an indefinite number of possible answers, will perhaps see that the first alternative (so long as it is a possibility) demands the most thorough exploration, whereas the second alternative, even if it should be right, is for the present not a very productive field of research.

A. S. EDDINGTON.

Observatory, Cambridge.
Aug. 10.

The Hardest Cosmic Rays and the Electric Charge of the Earth

SOME years ago[1] I detected the coincidences of cosmic radiation by placing two Geiger-Müller tube counters above one another and side by side. Repeating this experiment[2] in the salt-mine of Stassfurt (Berlepschschacht der Preussischen Bergwerks- und Hütten A.-G.) in different levels, systematic coincidences were still found in the first level, whereas in the fourth level no coincidences occurred within 3 hours. The coinciding corpuscular radiation in the first level, that is, at a depth equivalent to 500 m. of water, is predominantly directed in the vertical, the mass absorption coefficient $(\mu/\rho)_{H_2O}$ being less than 5×10^{-5} cm.^{2} gm.$^{-1}$, and the minimum energy greater than 10^{11} *e*-volt.

Earlier experiments with ionisation chambers[3] suggested that the radiation penetrates to 700–800 m. of water, which is now confirmed by further coincidence experiments. These rays are doubtless cosmic rays, at least four times harder than the hardest component found by Regener[4] at a depth of 230 m. in Lake Constance. On account of their energy, penetrating power and for other reasons, such as smallness of latitude effect, and so on, they may perhaps represent the primary cosmic radiation. Leaving the small number of incident rays out of the question for the present, a radiation has been found, which has the properties needed for a corpuscular penetrating cosmic radiation capable of maintaining the electric charge of the earth.*

W. KOLHÖRSTER.

Höhenstrahlungslaboratorium des
Meteorologisch-Magnetischen Observatoriums,
Potsdam. Aug. 10.

[1] *Naturwiss.*, **16**, 10 ; 1928.
[2] *Berl. Ber.*, 1933, in press.
[3] *Berl. Met. Institut*, 1931, p. 34 ; Berlin, 1932.
[4] *Z. Phys.*, **74**, 433 ; 1932.
* cf. Schweidler, "Probl. kosm. Physik, XV". Hamburg, 1932.

Development of the Lightning Discharge

IT is generally believed, though direct evidence has so far been lacking, that the first stage in the preliminaries to spark break-down is the passage from cathode to anode of an electron avalanche. It has been suggested that the real break-down occurs after the passage of this avalanche and proceeds from anode to cathode as a thermally ionised tongue.

We have recently obtained what appears to be very clear evidence of the reality of these effects in the case of the lightning flash, which we have studied with a revolving lens camera of the type invented by Prof. C. V. Boys. An example of the results obtained is shown in Fig. 1, where the two distorted pictures of the same lightning stroke have been mounted side by side with the directions of the lens movements outwards. Those corresponding points on the two photographs which are nearer together therefore actually occurred earlier in time.

It will be seen that the first event was the production of a faint track of uniform thickness which began near the base of the cloud and moved downwards. The uniform width of this track shows that its luminosity was such as would be produced by a downward-moving fireball or dart. The mean vertical velocity was $7 \cdot 2 \times 10^8$ cm./sec. and the width of the track is such as to make the maximum possible length of the luminous dart 36 metres.

This downward dart, on arriving at or near the ground, caused the development of an upward moving discharge with a more brilliant track, the distortion of the inside edges of which indicates a mean upward vertical velocity of $5 \cdot 3 \times 10^9$ cm./sec. The fact that this track is not of uniform thickness but is drawn

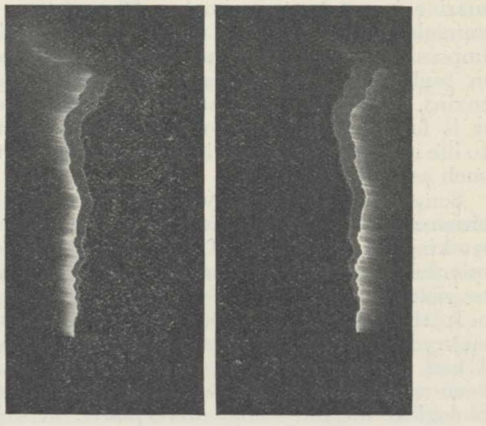

FIG. 1.

out more at its lower than its upper end, shows that the strong luminosity persisted at the base for some time after the discharge had moved upwards. The total length of the discharge was 2·1 km. and the luminosity at the base continued strongly until the head of the upward moving tongue was 1·2 km. above the ground. After this the luminosity at the base changed to a different form, with a shaded appearance on the photograph, which persisted until long after the discharge had reached the cloud.

We have found this combination of a downward-moving 'leader' with a stronger upward stroke to be very frequent. In the eleven discharges photographed by one of us (H. C.), there occurred 45 separate lightning strokes, of which 24 definitely were of this nature. The proportion would be much higher (24 out of 27) if we excluded those strokes which were not recorded under favourable conditions for seeing the leaders. Dr. E. C. Halliday has also very kindly shown us a photograph taken by him in which 4 out of 5 strokes show the same effect.

The upward stroke in the illustration is unbranched, but we have found others in which the branching is downwards, or directed away from the cloud, as previously reported by Halliday[2].

A full discussion of these photographs will shortly be published. We would identify the downward leader stroke with the electron avalanches, the cloud base acting as the cathode in the discharge. The subsequent discharge from the earth is considered to progress by a process of thermal ionisation.

This work forms part of a lightning investigation which is being conducted by a Committee of the South African Institute of Electrical Engineers, whom we thank for permission to publish this letter.

B. F. J. SCHONLAND.
University of Cape Town.
H. COLLENS.
Victoria Falls and Transvaal
Power Company,
Johannesburg.

[1] C. V. Boys, NATURE, 118, 749, Nov. 20, 1926; 122, 310, Sept. 1, 1928.
[2] E. C. Halliday, *Phil. Mag.*, 93, 409; 1933.

Habit and Structure in Starfishes

IT is, in general, extremely difficult to determine the exact purpose and function of the organs of marine invertebrate animals. Observation of such animals under purely natural conditions is often impossible: when they are captured and examined in tanks they are generally half-asphyxiated with toxins, and those familiar with aquaria know that it is far more difficult to acclimatise invertebrates to life in captivity than it is to acclimatise vertebrates such as fish.

Sometimes, however, by a happy concatenation of circumstances, one obtains a flash of insight into the working of the parts of an invertebrate such as months of carefully prepared experiments have failed to yield.

In the summer of 1905, when I was studying the embryology of the brittle star *Ophiothrix* at Plymouth, I had a consignment of these animals, which had been captured near the Eddystone, brought into the biological station. They were placed in a jar containing 'outside water', that is, sea-water dipped up outside Plymouth Sound. On the upper surface of the discs of nearly all brittle-stars there is a circle of ten plates shaped rather like the petals of a flower. There never had been any explanation of these plates adduced other than to attribute them to the mysterious forces of ornament and symmetry. But on the occasion of which I speak, to my amazement I saw the discs of these brittle-stars rising and falling like bellows. Then I remembered having seen in my sections of *Amphiura*, muscles connecting the upper and lower surfaces of the disc near the edge. The genital bursa, a pocket of the under side of the disc, which has a respiratory function, is attached by fibrous cords to the lower surface of the petal-like plate; this plate is hinged to a plate, termed the genital plate, placed on the lower surface of the brittle-star, running along the opening of the bursa. The result of this arrangement is that the petal-like plate and the genital plate act conjointly as a pair of bellows alternately expanding and compressing the genital bursa and thus forcing sea-water in and out of it. Under ordinary conditions, the influx of water is controlled by the motion of the cilia lining the bursa, but when the demand for oxygen becomes acute then this 'forced breathing' comes into play. That I was lucky enough to witness it I attribute to the circumstances: (1) that the supply of oxygen in the jar was being diminished by the rays of the evening sun shining through it; and (2) the sea-water was very pure and that the animals were therefore in a healthy condition.

This summer another lucky chance enabled me to understand the meaning of the differences of structure subsisting between different families of ordinary starfish (Asteriidæ). Two very distinct types of these starfish are common around our coast. One, typified by the ordinary starfish *Asterias*, includes denizens of clean clear sea-water with a relatively firm bottom over which they crawl. These starfish have clear, transparent, finger-like gills projecting from both upper and under surfaces. Their organs of locomotion (tube feet) terminate in suckers and by means of these the starfish can climb vertical walls of rock. The other type, represented by *Astropecten*, have gills only on their upper surface, their tube feet are pointed and they are consequently unable to climb; they are found on soft, muddy sand over the surface of which they run. They eagerly consume bits of somewhat stale fish, and in Plymouth they can be seen to swallow these. After the meal is completed, they proceed to bury themselves in the sand. The body is completely covered except for the centre part of the back which is raised into a cone projecting into the water, and on this cone nearly all the gills are concentrated. In the deep-sea family Porcellanasteridæ this cone has become a permanent organ: it is cylindrical and long and was interpreted by Perrier as a remnant of the stem which, he thought, the supposititious Crinoid ancestors of the starfish must have possessed! Thus the temporary elevation of the back in one family has become a permanent structure in an allied family.

This summer I had sent me from Plymouth a consignment of the common starfish *Asterias*. I desired to repeat the experiment once before successfully carried out in my laboratory, of rearing the eggs of this form through the larval stage to maturity. These starfish are delicate organisms, and if sent packed in damp seaweed, usually fail to survive the passage from Plymouth to London. Accordingly they were sent to me in a large tub half full of sea-water hermetically sealed. All arrived in London living but not very active. To revive them they were placed in one of our shallow laboratory tanks and an air-circulation was introduced into the water. The air pipe did not reach the bottom of the tank—in fact, it projected only a few inches below the surface. To my amazement I found that all the starfish had elevated the centre of the back—in the manner just described for *Astropecten*—so as to bring this part of the body into contact with the air-bubbles which were being shot into the water. Under natural conditions, one would think that this elevation of the back must rarely be called for: but evidently the power to produce it is present in all starfish, and in *Astropecten* and its allies, with the assumption of the burying habit, this power has been intensified and specialised.

Truly structure is only frozen habit.

E. W. MACBRIDE.
Imperial College of Science and Technology,
London, S.W.7. Aug. 18.

Effect of Yeast Extract on the Growth of Plants

CULTURE experiments which we have carried out with peas have shown that yeast extract—prepared by heating yeast in water—stimulates to a remarkable extent the development of blossoms. In these experiments, the plants were grown either in sterile culture fluids (pH 6·5) or in quartz sand, watered with Hiltner's nutriment solution. Nitrogen was supplied to the plants either in the form of nitrates or by inoculating the seed with active bacterial strains. When suitable amounts of yeast extract were used, the test plants started blooming 5–10 days earlier than controls (test-plants 20–25 days, controls about 30 days after sowing). The number of pods was invariably some 50 per cent greater when the plants were given yeast extract. Excessive amounts of yeast extract were found to cause deleterious effects. Work is in progress to find out which particular factor in yeast extract is responsible for the stimulating action. Particular attention will be paid to the question whether the factor which stimulates the growth and blooming of plants is identical with the factor stimulating the cell division of micro-organisms.

Follicular hormone was found to have no stimulating effect on the development of blossoms.

ARTTURI I. VIRTANEN.
SYNNÖVE V. HAUSEN.

Biochemical Institute,
Helsingfors.
Aug. 9.

The Sycamore Fungus

THE circular black spots on the leaves of the sycamore, *Acer pseudoplatanus*, caused by attack by the fungus *Rhytisma acerina*, form such a familiar feature in the foliage of that tree that they are apt to be regarded as natural marks, like those on the mottled leaves of *Pulmonaria officinalis*.

Although I have given some attention to the matter, I have never found a sycamore without these blotches; until lately, in going through the plantations at Corrour in Inverness-shire, I noted that none of the sycamores had been marked by *Rhytisma*. It is true that these plantations are only from twenty to thirty years old, the ground having been treeless, except for a few scattered birch and alder, when Sir John Stirling Maxwell undertook experimental planting at an elevation of 1,200–1,400 ft. above sea-level; but I have failed to find anywhere else sycamores of that age free from the fungus.

Rhytisma has no perceptible effect upon the vigour of its host. It will be interesting to note whether, under conditions of climate in the Scottish Highlands, it will ever make its way to this high altitude and establish itself on the sycamores at Corrour.

HERBERT MAXWELL.

Monreith.

Exceptional Behaviour of the Synergids in the Embryosac of Angiosperms

THE synergids in the embryosac of angiosperms usually degenerate as soon as the process of fertilisation has been completed. During the course of a morphological study of *Ammania baccifera*, Linn. (Lythraceæ), however, we have found them to be persistent up to a very late stage of embryo formation and even to develop further during this period in a very peculiar manner which, so far as we have been able to find, has not before been reported in any flowering plant.

The embryosac of *Ammania baccifera* is perfectly normal and of the usual 8-nucleate type. There are three antipodal cells, two polar nuclei and an egg-apparatus of one egg-cell and two synergids. Both the synergids are uninucleate and quite distinct from each other before fertilisation; but so soon as this process is completed they begin to expand in all directions. Laterally their walls begin to press upon those of the other and finally dissolve. The two synergids from now onwards thus form a single structure more or less resembling a collar around the suspensor of the growing embryo. The nuclei of the synergids also divide a number of times as the latter increase in size. The synergids thus become multinucleate—the number of nuclei of both the synergids taken together becoming very often so many as 7–9. The divisions that give rise to such a large number of nuclei from the original two take place amitotically.

The above behaviour of the synergids in *Ammania baccifera* we have found to be constant. We have examined several hundred embryosacs and in every case we have found them to unite with each other laterally and become multinucleate after fertilisation simultaneously with the development of the embryo.

A. C. JOSHI.
J. VENKATESWARLU.

Department of Botany,
Benares Hindu University,
Benares, India.
July 20.

Observations on *Arenicola marina*

ON July 19 whilst passing across the Dee sands (Cheshire) from Heswall to the cockle beds, many thousands of the common lugworm, *Arenicola marina*, were seen lying out of their burrows partly or completely exposed on the surface of the dry sand and in pools almost everywhere at half-tide level, while numbers were being washed downstream in the drainings from the sands with little chance of survival. None had been seen on similar visits made on May 27 and 31.

Of 116 individuals examined microscopically on July 19–20, 59 were females with almost ripe eggs and 45 were ripening males, of which 16 had tailed sperm-morulæ. No parasites were noticed in the coelomic fluid; other parts were not examined.

The general condition and habits of the worms indicated difficulties in respiration such as might be expected in very hot weather in an animal which does not appear to have a high oxygen reserve[1]. On July 20, temperatures of 71°–75° F. were recorded in pools and streams between 4 and 6 p.m., but whether such levels are very abnormal appeared doubtful. Later, on July 27, the Cark sands, Morecambe Bay, were visited and temperatures of 72°–78° F. on the afternoon ebb tide were recorded where lugworms were extremely abundant below the sand but none were on the surface. On July 31 extruded worms were still abundant on the Dee at environmental temperatures of 60·8°–61·6° F. Hence it was felt that high temperature, although possibly of incidental importance, was probably not the cause of the remarkable migration of the Dee worms. On the Dee, the general biological conditions were healthy so far as could be inferred from the presence of millions of young shrimps (*Crangon*) and shoals of gobies in pools and streams, and a heavy spatfall of tiny cockles ranging from 1·2 mm. on the adjacent beds. The presence of large numbers of rotting cockles[2] (and *Macoma*) in the neighbourhood, however, indicated that a bacterium feeder might have become abundant and attached to the gills or merely harassing the worms in their burrows. A sample of 29 worms, which were partly but not wholly protruding from their burrows, were therefore carefully examined (July 31) and 20 of them found with slight to heavy infection of an unidentified fungoid organism, exhibiting fungal-like threads extruding from the gills, or ramifying on the setæ. It is not known whether the presence of this organism on *Arenicola* is abnormal, but it seems probable that such an infection may afford on further investigation a partial or complete explanation of the migration from the burrows. The occurrence of a fungus in an estuary noted for salmon is a matter of considerable interest to those concerned in the health of this important fish, especially as a pathogenic marine fungus allied to the Saprolegniaceæ is known to occur in *Pinnotheres*[3].

Further investigations are highly desirable and may reveal whether the recent unusual events[2] in this district have a common cause and are related to alleged local pollution. The approach to sexual maturity shown in *A. marina* from half-tide level in this locality confirms the suspicion of Ashworth[4] that the 'littoral variety' on these coasts breeds towards the end of summer, whereas similar worms living at the level of low-water springs in many other localities usually breed in spring.

J. H. ORTON.

Department of Zoology,
University of Liverpool.
Aug. 10.

[1] Barcroft, J., and Barcroft, H., *Proc. Roy. Soc.*, B, **96**, 28 ; 1924.
[2] Orton, J. H., NATURE, **132**, 314, Aug. 26, 1933.
[3] Atkins, D., *J. Mar. Biol. Assoc.*, **16**, 203 ; 1929.
[4] Ashworth, J. H., Cat. of Chæt. in Brit. Mus., A., Polychæta Part 1, Arenicolidæ, 1912.

Cumulus Clouds, Convection Currents and Gliding

IN his interesting letter on this subject[1], Dr. F. J. W. Whipple seems to imply that the coldness of a cumulus cloud relative to its environment represents a new discovery on the part of W. Kopp. Perhaps I may be allowed to point out that I noted this fact in 1917[2], and soon afterwards wrote in the columns of NATURE[3], ". . . the lapse-rate near the ground is adiabatic, but this is not usually the case at the cloud level, with the result that the clouds at the top of the ascending currents are usually colder than the surrounding air". Later research has shown that on a sunny day the lapse rate of temperature considerably exceeds the adiabatic rate in a shallow layer near the ground. I incline to the opinion that the rising air mass resembles a bubble, and that it gains vertical velocity in the lower unstable layer, and loses it higher up, but is carried by its own momentum past its equilibrium position. If this view is sound, it follows that a rising current should be found only under a developing cumulus cloud, but that under a dissolving cloud the motion should be downward. It would be interesting to know whether gliders can confirm this.

As regards large cumulus and cumulo-nimbus clouds, I find among my War-time notes a number of observations on this subject. The temperature in the cloud was sometimes lower than in the adjacent air at the same level, sometimes higher, and sometimes about the same. On showery or thundery days the cumulus clouds are started off in much the same way as on fair days. If one watches the clouds carefully, one sees that some of the clouds dissolve away, while others continue to grow and join with others, usually along a belt, and perhaps finally form thunderstorms, after a total period varying from two to six hours. Buoyancy is evidently sometimes lacking at the cloud base, but is developed higher up owing to the latent heat of condensation, provided that the lapse-rate of temperature in the surrounding air exceeds the saturated adiabatic rate. At still greater heights the cloud top may penetrate a more stable layer and again become colder than its environment, but in the case of thunderstorms buoyancy is usually maintained to above 15,000 feet. The strong rising currents of thunderstorms are evidently a late development, since otherwise the development of the storms would be much quicker than it actually is. In the earlier stages there must often be a delicate balance between the factors producing ascent of air and those opposing it. Horizontal temperature gradients, convergence in the horizontal air motion (especially below 2,000 feet), or topographical features on the ground play a part in most if not all thunderstorms, though these factors are ineffective without a suitable lapse-rate of temperature higher up.

The number of upper air soundings on thunderstorm days is now very large, and it is found on these occasions that by far the most potent forces of buoyancy acting on an air mass rising through its environment act appreciably above the condensation level. In the absence of observations in the heart of the storms, it is usually assumed that the air rises adiabatically, and though mixing between the rising air and its environment may modify this in practice, the general qualitative conclusion regarding the main source of the buoyancy remains unaffected. Another complication is the cooling effect of precipitation, especially of hail and snow melting into rain. The air in a shower is normally colder than at the same level outside it, often up to 5,000 feet, and probably sometimes higher. This destroys the buoyancy of the air, and the downward current causing the outrushing squall probably sometimes originates above 5,000 feet. The shower is maintained by fresh masses of rising air at its boundary, usually in front of it but sometimes also (or alternatively) behind or at the sides. There is thus always a tendency for the old parts of showers or thunderstorms to diminish, and for the new parts to intensify.

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Aug. 23.

[1] NATURE, **132**, 276, Aug. 19, 1933.
[2] *J. Scot. Meteor. Soc.*, **17**, 140 ; 1917.
[3] NATURE, **101**, 87, April 4, 1918.

The Knock-Rating of Heptine-1

IN the past few years a large number of pure hydrocarbons have been tested as regards their knock-rating in test engines and it is now possible to compare many pure hydrocarbons that boil in the petrol range as regards their engine performance.

Collected data on the knock-ratings of pure paraffinic, naphthenic, unsaturated naphthenic, aromatic and olefinic hydrocarbons have recently been published by one of us (F. H. G.) and Evans, Sprake and Broom[1]. It was thus desirable to extend this list to include a liquid acetylenic hydrocarbon. Heptine-1 was prepared by the method of Meunier and Desparmet[2] and Bourguel[3] by the action of sodamide on 1 : 1 : dichloroheptane, the latter being prepared by the action of phosphorus pentachloride on heptaldehyde[4]. In the sodamide-dichloroheptane reaction a technical white oil was used as diluent. The product boiling between 98° and 101° C., 750 mm. was obtained in a 33 per cent yield; its physical constants were:

$$n_D^{19^\circ\,C.} = 1{\cdot}4093,\ D_{4^\circ\,C.}^{25^\circ\,C.} = 0{\cdot}727.$$

The knock-rating of the hydrocarbon was determined in the 'Ethyl Gasoline S.30' (modified Delco) testing unit in a 20 per cent volume blend with a standard spirit, the engine jacket temperature being 100° C. The blending octane number of the heptine–1 was found to be 79·5.

It is of interest to record the knock-rating of this hydrocarbon together with representative hydrocarbons of seven-carbon atoms of other series, each being rated on the *n*-heptane = 0, *iso*-octane (2·2·4 trimethylpentane) = 100, standard:

Hydrocarbon.	*Blending Octane Number* (At jacket temperature of 100° C.).
Heptine–1	79·5
Heptene–1	59·5
Heptene–3	113·5
n–Heptane	0
Ethyl*cyclo*pentane	57
Methyl*cyclo*hexane	75
*Cyclo*heptane	26·5*
1–Ethyl*cyclo*pentene	101·5*
1–Methyl*cyclo*hexene	132·5*
Toluene	113

*Lovell, Campbell and Boyd (see [1]).

It is thus apparent that the introduction of a double bond into the heptane molecule in the α position increases the blending octane number considerably, and that the introduction of a treble bond in the same position further increases this value though not to so great an extent.

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[1] World Petroleum Congress, London, 1933.
[2] *Bull. Soc. Chim.*, **35**, 481; 1924.
[3] *Ann. Chim.*, **3**, 191, 325; 1925.
[4] Hill and Tyson, *J. Amer. Chem. Soc.*, **50**, 172; 1928.

Pleochroism and Birefringence in Crystals

PROF. W. L. BRAGG[1] explains the strong birefringence of some carbonates and nitrates as being due to the interaction of the optical dipoles induced in the component atoms. For example, X-ray analysis shows that the carbonate ions in calcite have a plane structure, their planes being perpendicular to the optic axis of the crystal. With this arrangement, the interaction of the dipoles results in a much smaller refractivity for vibrations along the optic axis than for perpendicular vibrations.

The effect of the interaction can also be regarded from a slightly different point of view. So far as observations in the visible and in the near ultraviolet regions are concerned, the effect would be equivalent to a change in the natural frequencies of the ions; for the nitrate, carbonate and similar ions, the natural ultra-violet frequencies will be increased for vibrations along their axes, while for perpendicular vibrations the natural frequencies will be diminished. The smaller refractivity for the former vibrations than for the latter, follows then as a natural consequence.

On this view we should expect, as we proceed from the visible region towards the ultra-violet, the absorption of these ions to begin earlier for vibrations perpendicular to the axis than for vibrations along the axis. That this is actually so for the nitrate ion was shown in a previous communication[2]. We have now studied the absorption of several other crystals, namely, calcite, dolomite and ankerite, which are uniaxial, and aragonite and potassium chlorate, which are approximately so. They all show pleochroism in the ultra-violet, which grows stronger with decreasing wave-length, the vibrations along their optic axes being less absorbed than the perpendicular vibrations.

In strong contrast with these crystals are anhydrite, celestite, barite and selenite, which show practically no pleochroism; as is well known, the birefringence of these crystals is very feeble.

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[1] *Proc. Roy. Soc.*, A., **105**, 370; 1924.
[2] NATURE, **126**, 12, July 5, 1930.

Integral Right-angled Triangles

THE series of series of $a^2+b^2=c^2$ in integral numbers does not seem to be familiar to mathematical friends, so it may be worth stating the foundation of the system.

a *b* *c*	△6	△10	△14	△18
2 : 0 : 2	8 : 0 : 8	18 : 0 : 18	32 : 0 : 32	50 : 0 : 50 etc.
△2 3 3	4 5 5	6 7 7	8 9 9	10 11 11
4 : 3 : 5	12 : 5 : 13	24 : 7 : 25	40 : 9 : 41	60 : 11 : 61 ,,
△2 5 5	4 7 7	6 9 9	8 11 11	10 13 13
6 : 8 : 10	16 : 12 : 20	30 : 16 : 34	48 : 20 : 52	70 : 24 : 74 ,,
△2 7 7	4 9 9	6 11 11	8 13 13	10 15 15
8 : 15 : 17	20 : 21 : 29	36 : 27 : 45	56 : 33 : 65	80 : 39 : 89 ,,
△2 9 9	4 11 11	6 13 13	8 15 15	10 17 17
10 : 24 : 26	24 : 32 : 40	42 : 40 : 58	64 : 48 : 80	90 : 56 : 106 ,,
etc.	..	..	..	..

The usual 3 : 4 : 5 begins here as 4 : 3 : 5, underlined to catch the eye. Carried further, at the 14th rank we reach 336 : 377 : 505 for instance. There are nineteen such triangles without requiring three figures.

FLINDERS PETRIE.

The Rise of the Himalaya

MR. L. R. WAGER, in his interesting letter regarding the rise of the Himalaya[1], ranges himself on the side of those who believe that the outer ranges of the Himalaya are in isostatic adjustment.

Gravity data seem to be opposed to this view. Since gravity is in excess at Simla, Chakrata, Mussoorie, Lansdowne, Ranikhet, Sundakphu and Darjeeling, recent uplifts of these parts, so far from favouring isostatic adjustment, have been diametrically opposed to it.

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[1] NATURE, **132**, 28, July 1, 1933.

Research Items

Fossil Man in China. In view of the Fifth Pacific Science Congress and the Fifteenth Geological Congress this summer at Vancouver and Washington respectively, the Cenozoic Research Laboratory of the Geological Survey of China has summarised existing knowledge relating to Peking man and the Cenozoic history of China in a single volume ("Fossil Man in China", Geological Memoirs, Series A, No. 11). Although contributions from members of the Laboratory have appeared in various publications, which cover practically the same ground, not only is it a matter of convenience to have the material collected in one volume, but there is also the added advantage of the perspective given by the editorship of Prof. Davidson Black, the director of the Laboratory, after discussion of various points with members of the staff, who have been responsible for work in the field. P. Teilhard de Chardin is the author of the first chapter, which deals with the Choukoutien deposits and the late Cenozoic of China; Prof. Davidson Black discusses the *Sinanthropus* skeletal remains and other north China fossil hominids; and P. Teilhard de Chardin deals with the *Sinanthropus* cultural remains and summarises the evidence of other ancient cultures in north China. Prof. Black emphasises the fact that although each section is based on the individual work of the authors, the conclusions represent their unanimous opinion as a group. As thus presented in new form, and especially as representing the considered conclusions of P. Teilhard de Chardin, the material will be found to repay careful examination. It is pointed out, for example, that the faunistic evidence of Choukoutien points to an interchange with the south, but that the situation provides no sound argument for a southern derivation of *Sinanthropus*, since *Pithecanthropus* was provided with a dentition much too highly specialised to have been ancestral to *Sinanthropus*. On the other hand, certain difficulties remain, such as those which have led Prof. M. Boule for one to question the attribution of the development of a lithic industry relatively so advanced and the use of fire to a being of a generalised type such as *Sinanthropus*, differing essentially on one hand from modern, Neanderthal and Rhodesian man, and on the other from the anthropoids.

Cancer Inheritance in Mice. In a study of the inheritance of susceptibility to cancer in mice, Mme. Dobrovolskaia-Zavadskaia (*J. Genetics*, vol. 27, No. 2) produces further evidence on this complicated subject. In experiments extending over several years she has obtained data from 14 strains numbering nearly 1,500 mice. The frequency of cancer ranges from less than 2 per cent to 75 per cent in different strains, although they live together under the same conditions and often in the same cages. Four new strains are described, three of which were derived from mothers which died of adenocarcinoma of the mammary gland, and the offspring of which showed 48 per cent of malignancy. The other strain produced small non-malignant cysts and only 1·7 per cent of mammary adenocarcinoma. Strains showed marked differences in the incidence of various kinds of tumour. Thus among 12 strains derived from mothers which died of mammary adenocarcinoma, three manifested no other kind of tumour, while in the nine remaining strains this condition was also prevalent. In another strain, the male parent of which died of sarcoma, the females belonged to a short-tailed stock in which 5 per cent of the 200 tumours were developed in the occipital region. In this strain 45 tumours appeared, 29 per cent of which were in the occipital position, whereas in all other strains only one of 212 mammary adenocarcinomas showed the same localisation. This appears to be clear evidence of the introduction of a localising effect through a cross, due to the presence of a modifier in the short-tailed stock. The hypothesis is introduced of a common gene for neoplastic growth in general, with a series of accessory modifiers for the various kinds of histological structure.

Reaction of Soils upon Animals. The possible influences of the chemical conditions of soils upon the creatures which exist upon them have not been fully realised, and Dr. Stewart MacLagan has studied the relationship in a series of selected types (*Proc. Roy. Physical Soc., Edinburgh*, 22, 107; 1933). Indirectly, even vertebrates may be affected by the composition of the soil, since acid content is reflected in the composition of the herbage and this may be expressed in calcium deficiency, as in the 'bent-leg' disease of sheep. Earthworms and snails are most numerous in soils which are approximately neutral in reaction, and a series of experiments with the primitive insect (Collembola) *Smynthurus viridis*, showed that soil reactions appreciably influenced the duration of the reproductive phase, and profoundly influenced the reproductive capacity of the insect. Since Collembola, like earthworms, swallow soil, it is suggested, from morphological and physiological evidence, that they also may have the power of modifying the 'acidity' of the soil, so that they gradually create a more favourable environment for their own existence.

Anatomy of South Indian Frogs. The half-yearly *Journal of the Mysore University*, vol. 6, No. 1, January 1932, recently received, contains a paper on the posterior lymph-hearts of certain south Indian Amphibia—two aquatic species of *Rana*, and terrestrial species of *Cacopus* and *Bufo*. In the first two examples the lymph-hearts are bilobed and trilobed respectively, in *Cacopus* the lymph-heart is conical, in *Bufo* oval. Thus the lymph-hearts of aquatic species suggest the multiple lymph-hearts of certain Urodeles. The vascular connexions of the lymph-hearts are noted. In other papers the cranial osteology and the structure of the hyoid apparatus and the larynx in three south Indian Engystomatidæ (Anura) are described and figured.

Peat Soils and Vegetation in Scotland. At the instance of the Forestry Commission, the Department of Forestry of the University of Aberdeen has undertaken investigations into the establishment of timber crops on peat soils in Scotland and particularly under west coast conditions as illustrated at Inverliver on Loch Awe. Dr. G. K. Fraser of the Aberdeen Department of Forestry contributes an account of these investigations in Forestry Commission Bulletin No. 15, "Studies of Scottish Moorlands in relation to Tree Growth" (H.M. Stationery Office, London, 1933). Much of the peat land is of course unsuitable for agriculture, and according to present knowledge, would appear only economically utilisable for afforestation purposes. The author classifies the different kinds of peat upon a broad pedological basis, within which further divisions are made according to their structure and vegetational origin. It is held that two points emerge from the inquiry: first, that there is a lack of success in planting trees on that class of peat which is characterised by deer grass and heather (the *Scirpus* high moor type) and, second, the value of basic slag combined with methods of turf-planting. The Bulletin deals with origins and development of peat; physiological features and vegetation of the western Scottish moorland region; effect of long-continued heather burning and grazing upon the moorland vegetation of west of Scotland; peat and its associated types of vegetation; soil-forming (edaphic) properties of peat; sylvicultural quality of peat soils—as assessed by the rate of tree growth; and sylvicultural improvement of peat areas.

Moisture Content of Farm Products. A definite need exists for a cheap and rapid method for estimating the moisture content of various farm products in the field, to enable agriculturists to determine with a greater degree of safety when grain may be stored and hay carted. W. H. Cashmore, of the Agricultural Engineering Institute, University of Oxford, has developed a method, similar to that described earlier by Bouyoucos, based on the fact that finely divided grain rapidly gives up moisture to alcohol until a definite distribution of water between the grain and the alcohol is reached (Institute for Research in Agricultural Engineering: University of Oxford. "A Rapid Method for Measuring the Moisture Content of Wheat". By W. H. Cashmore. Pp. 24. Oxford. 1*s*.). The amount of water given up to the alcohol varies with the moisture content of the grain, and can be measured by finding the increase in the specific gravity of the alcohol. The necessary apparatus is cheap and simple and an estimation can be made in half-an-hour. Definite quantities of meal and methylated spirits are mixed, stirred, and filtered after twenty-five minutes, the specific gravity and temperature of the filtrate being taken immediately. The moisture content of the meal is then read from a calibration table, corrections for various sources of error being made if necessary. The method can be adapted for hay, which is finely cut instead of ground, and for soil, the technique varying slightly according to the material under examination. It is possible that the method might also be adapted for materials of high moisture content, estimations of which are often difficult and take much time.

Ice in the North Atlantic. The report for 1932 of the International Ice Observation and Ice Patrol Service in the North Atlantic (U.S. Treasury Department, Bulletin No. 22) records a somewhat unusual year in the distribution and occurrence of icebergs. While the forecast for the number of bergs south of lat. 48° N. during the first seven months of the year was about three hundred, the actual number was 514. Until March, as usual, there were very few, but then they began to increase rapidly in numbers. April had 321, which was some four times the average number. May had many less than the average of 130, which generally marks the peak of the southward flow, and in June the season practically ended. The report gives detailed charts for each month showing the distribution of ice. In spite of the fact that several bergs drifted on to the recognised steamer tracks, there were no shipping disasters due to collisions with ice.

The 42-Minute Periodicity of After-Shocks. The time taken by the earthquake-wave from a focus near the surface to travel to its antipodes is almost exactly 21 minutes. As the crust near the focus remains for some time in a sensitive condition, the return-waves, as Dr. C. Davison has shown (*Amer. Seis. Soc. Bull.*, 23, 57–79; 1933), affect the frequency of the after-shocks. For example, one of the stronger after-shocks of the Kwanto earthquake of 1923 occurred 41 min. 36 sec. after the great earthquake, while the second principal earthquake followed the first after the lapse of 1,428 min. 11 sec., or 11 seconds more than 34 intervals of 42 minutes each. As a rule, the 42-minute period is confined to the after-shocks of great earthquakes, but even in those of a few earthquakes of semi-destructive intensity, the period can be traced. The maximum of the period usually coincides with the return-movements or, and especially with the great world-shaking earthquakes, halfway between those returns. After an interval, ranging from about six hours to six or more days, the epoch may be reversed. In certain great earthquakes, more than one such reversal may occur. In the Mino-Owari earthquake of 1891, one record gives 7 reversals in the first 13 days, and, in the Kwanto earthquake of 1923, there were at least 8 reversals in 10 successive days. In moderately strong earthquakes, the period is perceptible for about 15 days; in great earthquakes for two, three or even four months. The reversals of epoch are due, not to any change in the variable force, but to changes in the causes of the after-shocks, probably to the tilting of crust-blocks in opposite directions.

Thermal Effects of Certain Elements. Sterba-Böhm and Dorabialska (*Coll. Czechoslovak Chem. Comm.*, June 1933) report that the oxides of scandium, yttrium, praseodymium, tantalum, antimony, bismuth and arsenic, and scandium formate and lanthanum oxalate, produce a small rise of temperature in an adiabatic calorimeter, whilst other oxides (neodymium, samarium, beryllium, etc.) and compounds (gadolinium oxalate, etc.) produce no effect. The conclusion is reached that the elements which produce the effect have odd atomic numbers. A possible explanation of this result, however, is furnished by some experiments of Barry and Barnett (*J. Amer. Chem. Soc.*, August), who found a slow evolution of heat from massive gold in a calorimeter. This effect was shown to be due to the slow adsorption of water vapour on the metal. The heat evolution in seven hours was 0·0276 gm. cal. per sq. cm. of surface, and when extrapolated exponentially to infinite time was 0·0397 gm. cal. per sq. cm. The quantity of water deposited, determined by direct weighing, was for infinite time $24{\cdot}76 \times 10^{-6}$ gm. per sq. cm. The rate of deposition was exponential and it is thus calculated that the heat developed in the process diminishes from an initial value of 7,570 gm. cal. per gm. to a final value approximating to the latent heat of vaporisation, 560 gm. cal. per gm. The total heat evolved is 1,601 gm. cal. per gm. The phenomenon is not an adsorption in the usual sense; it appears to involve the occlusion of water vapour by gold and to be at least affected by capillary imbibition.

Permanence of Publications and Records

IT is appropriate that a body such as the International Institute of Intellectual Co-operation of the League of Nations should make a matter such as the permanence of records one of its concerns, and a report (prepared by Mr. E. Whalley) has recently been published. It is of interest not so much as a record of experimental work, but as a statement of the attitudes of the countries concerned, for it consists mainly of the replies to a questionnaire asking for information on the state of preservation of publications and records and on the most desirable methods of preservation.

The preservation of certain printed and written documents is of importance, however small the country concerned, but it appears that in many instances, such as in Austria, Bulgaria, Cuba, Denmark, Holland, Italy and Luxembourg, many of the records belonging to the War and post-War periods are printed or written with materials which will not last. Presumably this state of affairs is due mainly to the War, but it may also be accounted for, to some extent, by the interval which has elapsed between the partial replacement of rags by esparto or wood pulp and the accumulation of scientific evidence as to the dependence of stability on the materials used and on the method of preparation.

The most useful contributions come from Great Britain and the United States, since actual specifications are given, and in the former case the views of several Government departments are expressed separately. Thus, the Public Record Office notes that the decade 1890–1900 may be regarded as the danger-period, so far as instability of paper is concerned, while the Stationery Office contributes its various specifications, which incidentally demand an all-rag composition with a minimum of added non-fibrous constituents. It appears that the British Museum takes no special precautions other than the exclusion of moisture for the preservation of printed books, although manuscripts are, in addition, protected against dust. The use of papers of special quality for copies of publications to be deposited at the Museum under the Copyright Act is commended. A general report was also received from the Government Chemist.

The subject has received considerable attention in official quarters in the United States, and as the conclusions reached are based on organised experimental work they are of great interest; this is particularly the case since resistance to discoloration figures in the report. This factor, which has been somewhat disregarded in the past, is important not so much because the discoloration itself is objectionable as because a paper which discolours relatively rapidly in sunlight will deteriorate rapidly on storage. This is not surprising, since the discoloration of white papers is almost certainly related to degradation of the cellulose by chemical impurities. At the same time it is unwise to place too much trust on a high content of α-cellulose as a guarantee of permanence, since the investigations of W. V. Torrey and E. Sutermeister[1] on a number of papers up to 900 years old demonstrate that there is no connexion between the two; it is now being gradually appreciated that the chemical purity of the paper as a whole is of more importance than that of the fibrous portion only.

No less important than paper for the preservation of the written word is ink. It seems generally agreed in all quarters that carbon black is the most desirable ingredient, and a recommendation comes from Germany to the effect that the use of blue and violet typewriter ribbons for permanent records should be prohibited. The work of Holweck in Norway has enabled a specification to be compiled for ink, and a mobile, quick-drying, non-fading iron and tannin black ink, which is free from acidity and resistant to light, water or alcohol is preferred.

The recommendations of the Committee should serve as a valuable guide to those responsible for the selection of paper. Paper of appropriate chemical purity made from unbleached rags is still preferred; and iron tannate inks, and carbon papers and typewriter ribbons prepared from carbon black, are considered to be the least destructive of those available. At the same time it is appreciated that these are not ideal, and there appears to be scope for further work on the subject of inks. The publication of special limited editions of newspapers on a rag paper is to be encouraged, and all documents should be bound as soon as possible.

An important recommendation refers to conditions of storage. Extremes of temperature, humidity and light are the most potent accelerators of deterioration, but dust, insects and bad binding also play a part. In this connexion it is understood that humidity and temperature control has been installed at the Archives Building at Washington, D.C. Permanent displays of documents are undoubtedly responsible for hastening deterioration and are therefore undesirable. The chemical purity of the air is also worth consideration since A. E. Kimberly[2] and others have recently shown that books from libraries in towns deteriorate more rapidly than those from country libraries, presumably owing to the higher sulphur dioxide content of the air in the former case.

Finally, the committee decided that a bulletin should be issued from time to time as a means of directing attention to recent developments in science which have a bearing on the above matters.

This article would be incomplete without reference to a report of the Technical Association of the American Pulp and Paper Industry which has just appeared[3]. In addition to discussions of the individual effects on stability of the various fibrous and non-fibrous constituents of paper, this attacks the difficult problem of accelerated ageing tests. These tests usually involve a determination of the change in certain physical tests (for example, resistance to folding) after heat-treatment under specified conditions. Unfortunately it is impossible to test the value of such tests other than by exposure for many years, but the opinion is expressed that they are of questionable value for inclusion in specifications. In the meantime, therefore, the only reliable alternative is to select a paper similar to those which have already stood the test of time, and it seems that until the passage of time provides us with more information concerning the behaviour of wood and esparto pulps, unbleached cotton, hemp or flax fibres will continue to hold the field as the basis of durable papers.

J. G.

[1] *Paper Trade J.*, Tech. Sec., **96**, 267; 1933.
[2] *Bur. Stand. Misc. Publ.*, Nos. 128 and 140; 1933.
[3] *Paper Trade J.*, Tech. Sec., **97**, 37; 1933.

Learned Societies and Co-operation in Research

DR. R. E. MORTIMER WHEELER showed no little wisdom in his selection of a subject for his presidential address to the Conference of Delegates of Corresponding Societies at the Leicester meeting of the British Association. The position of the learned society in relation to the present tendency towards the centralisation and co-ordination of scientific research is becoming increasingly difficult. This applies more particularly to the local learned society of the older type, in which the amateur naturalist or archæologist once flourished. In London and the larger provincial cities, more especially if these happen to be university centres, a professional element helps to direct the activities of the society and to keep it in touch with scientific movement. Dr. Wheeler, however, evidently had in mind the smaller society of the provinces, which has done valuable work in the past, but at the present day is in danger of losing that enthusiastic support, which as the British Association has reason to know, was a valuable adjunct in securing the conservation of local antiquities or other material of scientific interest or importance, as well as in local scientific observation and record.

In urging the co-operation of local scientific societies in the promotion of scientific research by assisting in the work of centralisation and delegation, Dr. Wheeler drew his arguments in the main from his own subject of archæology. He indicated how by such co-operation the societies would assist in the avoidance of wasted effort and overlapping, and referred more particularly to the scheme which Sir Charles Peers, as president of the Society of Antiquaries, had drawn up, after consultation with local archæological societies, for a considered policy of research. Dr. Wheeler pointed out that the local societies of a generation or two ago promoted a great deal of research, varying widely in value, which, if it did not create a scientific understanding of archæology, established a widespread sympathy and understanding of that study. He went on to say, however, that the growth of professionalism in archæology, made necessary by the requirements of scientific technique, is bringing about an ever-widening rift between the professional and the layman, which is endangering the sympathy and help of the latter—more necessary in this branch of knowledge than in any other.

As a first step towards the re-establishment of sympathy between professional and layman, Dr. Wheeler deprecated the use of an obscure and pretentious technical terminology, which in archæology is noticeably becoming a jargon, in favour of a language intelligible to the general public—a discipline for the scientific worker which would compel a constant simplification and valuation of ideas. Secondly, he urged greater co-operation and more frequent opportunities of meeting between the learned societies of metropolitan centres and local learned societies. Co-operation in drawing up and carrying out schemes of organised scientific research was indicated as a possibility. In this connexion, in amplification of the term 'useful' as applied to such co-ordinated research, he referred to the work of the South-Eastern Union of Scientific Societies in ascertaining the distribution of a certain species of anopheline mosquito, which helped to counter the danger of a spread of malaria in England after the War. With this as an example, Dr. Wheeler emphasised the advantage to be gained from regional congresses or unions of scientific bodies as machinery for stimulating and co-ordinating effort, and referred to the steps which are being taken to form such a union for the midland area of England.

Plastics and their Genesis

IN a lecture delivered by Prof. G. T. Morgan at the Plastics Industrial Exhibition at the Science Museum, South Kensington, on July 19 and printed in *Chemistry and Industry* of Aug. 18, reference was made particularly to numerous intermediates of which formaldehyde, urea, thiourea and the tar acids are notable examples, since these enter into the composition of various typical artificial resins. These products have received particular attention at the Chemical Research Laboratory, Teddington.

Formaldehyde is manufactured by dehydrogenating methyl alcohol in presence of a catalyst such as copper or platinum, the former metal being preferred industrially. Methyl alcohol is derived either by fractionation from crude wood spirit obtained in wood distillation, or from high pressure synthesis. The latter process, which is especially serviceable in countries where coal is more plentiful than wood, is based on the condensation which occurs between carbon monoxide (1 vol.) and hydrogen (2 vols.) when this gaseous mixture is circulated at 450° and under a pressure of 200 atmospheres over a catalyst such as basic zinc chromate, which becomes reduced to zinc chromite. The main product (about 99 per cent) is methyl alcohol (methanol), but small amounts of higher primary alcohols (propyl and butyl) are also formed. Formaldehyde itself is a gas which dissolves readily in water so that it generally occurs in commerce as the 40 per cent aqueous solution known as formalin. It also occurs as polymerised paraformaldehyde and as its condensation product with ammonia, when it yields a colourless crystalline compound, $(CH_2)_6N_4$, known as hexamethylenetetramine, hexamine, hexa or H.M.T.

Enormous quantities of urea are now produced by high pressure processes from carbon dioxide and synthetic ammonia. Thiourea is made by heating ammonium *iso*thiocyanate at 140°, when a molecular rearrangement occurs recalling Wöhler's original synthesis of urea in 1828. By acting on either urea or thiourea alone, or a mixture of the two, with formaldehyde in presence of an alkali, syrups are obtained which are of the heat convertible resin class, so that they can yield moulded articles when mixed with paper pulp and heated under pressure. The glyptal resins are usually derived from glycerol and phthalic anhydride, and several procedures were mentioned whereby modifications can be effected in this group of plastics.

The phenol-formaldehyde resins are based on the pioneering work of L. H. Baekeland (1908). A resin of the bakelite type may be produced from a fraction of low temperature tar boiling at 180°–200° and the appropriate amount of formalin heated in the presence of the triethylamine as catalyst. The mixture speedily resolves itself into three layers, a supernatant layer containing neutral tar oils, a middle aqueous layer representing the water originally present in the formalin, and a bottom layer of crude resin. In practice this product may be purified either by solvent extraction or by steam distillation under reduced pressure. In this process, where the tar acids have not been isolated by the usual successive treatment with an alkali and acid, the main products are bakelite resin, a resin of the Novolak type extractible with organic solvents and used for spirit varnishes, and the neutral tar oils. In spite of the mixed character of the phenols, the resulting bakelite resins have been shown to have quite satisfactory electrical and physical properties.

In addition to monohydric phenols immediately derivable from coal tar, resorcinol and the naphthols have been suggested as resin components, especially for gramophone records. During the last three years, suggestive experiments have been made on condensations between formaldehyde and acetone. One, two, four or seven molecular proportions of aldehyde react with acetone and some three intermediates are obtained which have the property of resinification. The resulting resins are colourless and transparent; they may be either hard and vitreous or elastic, depending on the experimental conditions. Resins of the non-heat convertible type are obtainable by condensing formaldehyde with various aromatic hydrocarbons such as toluene and naphthaline.

Formaldehyde interacts very readily with aromatic amines even in aqueous solution or suspension. Such condensation products have recently been employed as intermediates in the production of resins for laminated board, having good electrical properties.

Attention was also directed to the increasingly important class of polymerisation resins. One of the most suggestive of this type, based on vinyl acetate, has been recommended for use in moulding, panelling and as a substitute for glass. Reference was also made to the polymerisation resins from acrolein, styrene, coumarone and indene. Styrene resins, which diminish a tendency to water absorption noticeable in vinyl resins, have been applied in making fountain-pen reservoirs. Coumarone and indene resins find their way into chewing gum and linoleum. Chlorinated diphenyl resins (aroclors) and toluene-*p*-sulphonamide resins, both possessing useful plasticising properties, were also mentioned.

University and Educational Intelligence

THE firm of Messrs. W. H. Allen, Sons and Co., of Bedford, has long paid particular attention to engineering training. Mr. R. W. Allen, the present head of the firm, referred to this subject in his presidential address to Section G (Engineering) of the British Association. He pointed out that the engineering industry cannot be carried on efficiently without a continuous supply of highly-trained engineers and craftsmen, and it is necessary to provide workshop training for three main classes of students. First, there is the student who wishes to become a professional engineer, capable of taking highly responsible positions on the administrative, executive and technical side of the industry and for whom a university training is desirable, ensuring that thorough grounding in the fundamentals without which no engineer can be complete. Then there is the student who comes into the works direct from the public or secondary school, who may by enthusiasm and determination attain to the same positions as the university-trained man. Lastly, there is the training of craftsmen by apprenticeship, to whom, however, the way to higher positions must not be barred. The 'scholarship ladder' from the elementary school to the university must have its equivalent 'apprenticeship ladder' in the works; it must be just as possible to-day as it was a century ago for a George Stephenson to begin at the bottom and achieve the heights. In every case, training should not be confined to the material and technical side, and although the passage of a student through the works may appear to be a severe and laboriously practical affair, it should at the same time engender a spirit very much akin to the public school spirit, which is essential to the formation of a true engineering character.

THE American University of Beirut, now in its sixty-seventh year, publishes in the current issue of its Bulletin of Information statistics of enrolments year by year from its foundation. These show that, excluding the preparatory school, there has been a continuous growth in numbers since 1920 from 381 to 1,004. The last figure includes 538 in a faculty of arts and sciences, 126 in the school of medicine, 38, 68 and 17 respectively in schools of pharmacy, nursing and dentistry, 54 in an institute of music and 163 in a French school on the lines of the seven higher classes of a lycée. The University is a private, non-sectarian institution, no Government subsidies have ever been received, and there is no connexion between it and the Government of the United States. Character-training is one of its principal aims and religious exercises are a part of the daily routine.

IN "The New Home-making Education" (Bull. No. 3 of 1933, Washington, Government Printing Office, pp. 56, 10 cents) the United States Commissioner of Education presents a digest of a series of addresses which constitute an answer to the challenge of Aldous Huxley's "Brave New World". The forces which are making for the disintegration of home and family life are analysed, and brief accounts are given of the educational measures actually in operation or projected by which it is hoped not merely to salvage the home, but also to rehabilitate it as a permanent and fundamental element of American civilisation. Various aspects of the problem are first stated from the points of view of the Federal Office of Education, of superintendents of schools, and of college presidents. These statements are followed by papers by an economist, a sociologist, a historian and a home economist, and finally there are proposals by various eminent authorities on education. The notion that the family as an institution has reached a stage of obsolescence and is destined inevitably to give place to a different grouping is combated with the thesis that, on the contrary, it has now, thanks to the increased productivity of labour making it possible for the poorest parents to have ample leisure for attention to their children, an unprecedented opportunity for developing its latent possibilities of service to humanity.

Calendar of Nature Topics

Most Northerly Position of the Doldrums

The circulation of the air over the tropical and sub-tropical parts of the Atlantic and Pacific Oceans comprises the north-east and south-east trade winds, and a region near the equator of calms and light variable winds, termed the 'doldrums'. The simplified explanation usually given for this circulation is that the heating effect of the sun being greatest near the equator, the warmed air rises there and is replaced by cooler air flowing in from each side ; the latter, deviated towards the west by the earth's rotation, forms the trade winds. In the northern summer the greatest heating occurs to the north of the equator and the whole circulation tends to move northward, but the air takes its temperature mainly from the sea, and owing to the sluggishness with which great volumes of water respond to seasonal changes of temperature, the movement of the circulation lags behind that of the sun, and the doldrums do not reach their most northerly position until early in September. For the same reason, the most southerly position is not reached until March.

British Foxes

An early clearing of the fields as was possible under harvest conditions in England this year, enabled the September cub-hunting to commence somewhat earlier than usual. From the fox-hunter's point of view, cub-hunting is necessary to reduce the abundance of foxes in certain areas, for too many foxes, rather than too few, spoil sport when fox-hunting commences in full in November. It has generally been stated that the British fox, *Vulpes vulgaris*, like the pheasant, and the capercaillie, would have become extinct but for its preservation in the interests of sport. The average fox stands about fourteen inches at the withers and averages some three feet in length, with up to 17 lb. for a dog and 14 lb. weight a vixen; but some large specimens are on record. In the *Zoologist*, 1849, J. Duff recorded a Durham specimen weighing 70 lb., measuring 4 ft. 9 in. from tip to tip, and the height at the shoulder 1 ft. 10½ in. In all probability, the 70 lb. is a mistake for 17 lb. in Duff's record. E. A. Vaughan (*Field*, Feb. 8, 1913) recorded one dug out in Dorsetshire with the fox and the bag it was weighed in totalling 25 lb., and in the following issue, F. Gooding, huntsman to the Monmouthshire Hunt, recorded a dog fox of 24 lb. F. C. W. Rushworth (*Field*, March 4, 1916) recorded a fox of 28 lb. 14 oz. killed near Keighley, Yorkshire. Pure white foxes have occasionally been recorded and Millais states that pied ones are not rare. A black fox with a white tag was seen several times in Leicestershire in 1923 but not killed, and a black fox has occurred in the New Forest (*Zoologist*, pp. 17, 97 ; 1890).

Icelandic Ducks begin to reach Britain

Although it is probable that some of the Icelandic passerine birds may already have arrived in Britain, and although the only tufted duck ever recovered with an Iceland ring was shot in Cheshire in August, it is in mid-September that the regular southward movement of these northern nesting ducks begins, as shown by the results of P. Skovgaard's ringing from 1925 until 1929 (Proc. Seventh Intern. Ornith. Cong., Amsterdam, 1931, p. 392). Amongst them the wigeon leads, and of four individuals recovered in September, three have been found in Scotland. Indeed it would appear that the majority of Iceland wigeon, on their first migration, winter in Scotland and Ireland, although older birds have generally been found farther south, even exceptionally in the north of Italy.

In another respect the dispersal of wigeon from Iceland is peculiar, for of the 29 individuals recovered (out of 294 ringed) four have occurred on the eastern seaboard of North America. As a rule, however, duck migration from Iceland is in a south-easterly direction to or through the British Isles, to Holland, the basin of the Rhine, and even to the Mediterranean Sea. For example, of 125 marked teal, eleven have been recovered, all on the line of route indicated ; and of 23 golden plover recovered out of 341 ringed, not one has occurred without the boundaries of the south-eastern route.

Unwelcome Gifts to Japan

About 1900, the United States presented (inadvertently) the pea-weevil (*Bruchus pisorum*) to Japan, and in some ten years it had become distributed throughout the whole country. Twenty years later, Europe, having already sent samples of her bean-weevil (*Bruchus rufimanus*) to New Jersey in 1870 and to the Chicago Exposition in 1893, contributed this additional pest to Japan either direct or by way of the United States. The invasion may be a serious one, for Japan in 1930 cultivated 41,190 hectares of broad beans, yielding a crop of 859,735 hectolitres. Accordingly Akira Kamito, of the Ministry of Agriculture at Tokyo, has been studying the habits of the beetle in Japan (*Proc. Imp. Acad.* Tokyo, 9, 137 ; 1933). September marks the close of its larval stages for the year ; for although only one generation seems to be reared each year, it spreads over many months, from the egg-laying of late April to mid-June to the last of the pupæ from which the adults emerge in October. The adults hibernate through the winter, reduced to a state of inactivity below 10° C., and showing slight activity when the temperature rises above 10° and moderate activity above 15°. In the state of hibernation, sheltered amongst stored beans, it survives for from seven to more than nine months, a viability very different from that of the active insect of summer, which lives for an average of only 34 days when supplied with abundance of food, and for 15 days without it.

Catch Cropping

One of the aims of arable farming is to produce the maximum amount of dry matter per acre suitable for direct sale or for feeding to livestock. An early season, such as the present one in England, enables a catch crop to be hurried in after harvest with the best prospect of success, provided that there is sufficient moisture left in the land for germination. Stubble turnips, Italian rye grass, rye, tares, or *Trifolium* can all make useful growth and provide good food for the following April, a time when fresh green food is most acceptable, as the pastures will not yet be fit to stock. Every day in August and September counts, and rapid preliminary cultivations are essential. If not required for feeding, these crops make green manures, and by covering the land in the winter they will have immobilised much of the nitrate which would otherwise have been washed out. They also contribute a supply of organic matter to the soil. Given clean land in a high state of fertility, and the means of conducting tillage operations at speed, catch cropping is a practicable method of using the growing season to the best advantage. This year winter oats and barleys were cut in the third week of July in many districts of England, presenting excellent opportunity for catch cropping.

Societies and Academies

Dublin

Royal Dublin Society, July 27. G. CRUESS-CALLAGHAN and M. J. GORMAN: Characteristics of *Bacterium violaceum*, Schröter, and some allied species of violet bacteria. Cultures of violet bacteria isolated from water samples appeared to be different from species previously described, but a comparative study of these cultures, and of as many as could be obtained from laboratories and collections elsewhere, led the authors to conclude that all those examined could, notwithstanding numerous differences among them, be regarded as strains belonging to three specific groups, namely, *B. violaceum*, Schröter, *B. janthinum*, Zopf, and *B. amethystinum*, Eisenberg.

Paris

Academy of Sciences, July 24 (*C.R.*, 197, 285–364). GABRIEL BERTRAND and L. SILBERSTEIN: The sulphur and phosphorus in the various parts of the wheat grain. The fact that earlier analyses have usually been carried out on the ash instead of the wheat has led to too low a figure being accepted for sulphur. The ratio of sulphur to phosphorus varies from 0·09 in the bran to 1·039 in flour. R. FOSSE and A. BRUNEL: The presence of allantoic acid in fungi. The examination of more than twenty varieties of fungi showed allantoic acid in proportion between 0·14 and 6·72 gm. per kgm. of dry plant. P. RACHEVSKY: A characteristic criterion of conformal representations. JULES SIRE: The problem of Dirichlet, the potential function and the ensemble of irregular points. MAURICE GEVREY: Some questions concerning the elliptic and parabolic types. Use of the peripheral or spatial mediation. Unicity of solutions of systems of equations. AURÉLIAN DONCESCU: The determination of the flame temperatures during expansion in internal combustion motors. The method used is based on that proposed by Féry in 1903 for the optical determination of the temperatures of non-luminous flames. Experiments with three different fuels are recorded as curves. A. PRZEBORSKI: The forces depending on accelerations. HADAMARD: Remarks on the preceding note. CH. RACINE: A class of solutions of the gravitation equations of Einstein. L. GOLDSTEIN: The theory of complex photoelectric effects. JEAN GUASTALLA: The equation of state of monomolecular films and comparison with the experimental results. P. BIQUARD: The absorption coefficients of ultra-sounds by different liquids. LÉON GRILLET: The variation of the intensity of the radiations emitted by a quartz mercury vapour lamp during the period of lighting up. Measurements of the intensities of the rays emitted by two arcs, one stable after running for some time, the other just started. E. BAUER, M. MAGAT and A. DA SILVEIRA: The Raman spectrum of calcium nitrate. Previous work by the authors and by Grassmann has shown that the Raman line 720 of the nitrate ion is doubled in very concentrated solutions of certain nitrates. Further experiments are described which disprove the hypothesis of Grassmann, that the effect is due to the presence of undissociated molecules of calcium nitrate. PAUL SOLEILLET: The calculation of the amount of polarisation of radiations emitted by resonance. GRINBERG: Emissions of positive electrons by the γ-radiation of Ra(B + C). G. MANO: The slowing down of the α-rays. Comparison between theory and experiment. M. BRIAND, P. DUMANOIS and P. LAFFITTE: The influence of temperature on the limits of inflammability of some combustible vapours. Data are given for the vapours of benzene, toluene, cyclohexane and cyclohexene for temperatures between 100° C. and 250° C. T. MOUNAJED: The volatility coefficient of hydrochloric acid in anhydrous ether. RAYMOND AMIOT: The adsorption by carbon of some phenols and polyphenols in aqueous solution. MLLE. B. GREDY: The acetylene linkage. Study of a series of 2-acetylenic hydrocarbons. Raman spectra of four hydrocarbons $R.C{:}C.CH_3$, where R is methyl, ethyl, propyl or butyl. M. PRETTRE: The influence of active nitrogen on certain oxidation reactions. The oxidation of carbon monoxide is accelerated by active nitrogen, and the temperature of inflammation is lowered. PIERRE THOMAS and MLLE. C. KALMAN: The action of various sugars on the reaction of solutions on sodium molybdate. A. BOUCHONNET, MME. TROMBE and MLLE. PETITPAS: The nitration of cellulose. The use of 99·9 per cent nitric acid in the presence of mineral salts (ammonium nitrate, potassium nitrate) gives nitrocelluloses containing up to 13·87 per cent nitrogen. R. LEVAILLANT: The preparation of some ether salts of chlorsulphonic acid or of sulphurous acid. P. RUMPF: A new colour reaction of aldehydes. The reagent is a solution of rosaniline hydrochloride in anhydrous formic acid: the colour changes are followed with the spectroscope. P. DUQUÉNOIS: The distinction between trivalent and pentavalent antimony by the formation of antipyrine iodostibnate. The reagent of Caille and Viel (antipyrine dissolved with potassium iodide) gives a golden yellow precipitate with antimonous salts, and with antimonic salts a brick-red precipitate. JACQUES FROMAGET: The presence of the *Gigantopteris nicotinæfoliæ* flora in Haut-Laos and the stratigraphy of the Indosinides. MME. Y. LABROUSTE: The periodic components of Love's waves. MLLE. A. DUSSEAU: The sporogenesis of the hybrid *Triticum haplodurum* resulting from the crossing of two *Triticum vulgare*. G. PETIT: A blind fish found in fresh water in a cavern in Madagascar: *Typhleotris madagascariensis*. A. GRUVEL: The distribution of some species of molluscs in the lagoons of Lake Timsah (Suez Canal). R. BONNET: The validity in the Pœcilotherms of the Terroine-Sorg-Matter law on the magnitude of the endogenous nitrogen expenditure. GEORGES BOURGUIGNON: Vestibular triple chronaxy. B. TROUVELOT, LACOTTE, DUSSY and THÉNARD: The elementary qualities of the plants supplying *Leptinotarsa decemlineata* with food and their influence on the behaviour of the insect. AUGUSTIN BOUTARIC, MAURICE PIETTRE and MLLE. MADELEINE ROY: The physico-chemical study of the flocculation of serum albumen by resorcinol. LÉON VELLUZ: The neutralisation of the diphtheric toxin by some heterocyclic molecules. The toxins of tetanus and diphtheria behave differently as regards their neutralisation by organic molecules; thus sodium diiodosalicylate is very active in neutralising the tetanus toxin, but reacts weakly with the diphtheria toxin. Details are given of the behaviour of the diphtheria toxin with ninhydrin, and with the sodium salts of rotenic acid and dihydrorotenic acid. G. FINZI : The properties of the blood serum and of the lactoserum of animals hyperimmunised against tuberculosis.

CAPE TOWN

Royal Society of South Africa, May 17. I. SCHRIRE and H. ZWARENSTEIN : (1) The effects of castration on the urinary creatinine of female rabbits. As late as eight months after castration, no change is seen in the urinary creatinine excretion of female rabbits. About the ninth month past castration, a definite rise is evidenced and a month later there is a maintained rise of 25–35 per cent. This rise is of the same order as that occurring in castrated male rabbits, but the interval between castration and the rise is from three to four times as long as that of the males. (2) The effects of injection of ovarian suspensions, ovarian extracts and testicular extracts on the urinary creatinine of normal and castrated female rabbits. Injections of ovarian suspensions and extracts cause a drop in the high creatinine excretion in castrated female rabbits to pre-castration levels. The drop is transient and in a day or two after injection the creatinine excretion is once more at the normal castration level. In normal animals the effect is slight. Testicular extracts, prepared in the same way as the ovarian extracts, act similarly to the latter. K. H. BARNARD : South African caddis-flies (Trichoptera). This is a further report on the fauna of the mountain ranges of the south-west Cape. A large number of new species has been discovered and the larval and pupal stages of representatives of 19 out of 23 genera found in the Cape area have been correlated with the adults. R. A. DART : The discovery of a Stone Age manganese mine at Chowa, North Rhodesia.

ROME

Royal National Academy of the Lincei, April 2. FRANCESCO SEVERI : Theory of the equivalence series on an algebraic surface : operations on the series (2). A. BEMPORAD : Stellar currents in Ursa Major. Comparison of the astrographic catalogue of Catania with the Yale IV catalogue reveals undoubted indications of the existence of these currents. S. CINQUINI : Successions of functions converging towards a holomorphic function. J. DOUBNOFF : Tensors of a single divergence. M. GHERMANESCO : The analyticity of the solutions of certain equations to partial, non-linear derivatives. S. GOLAB : An integral invariant relative to generalised metric spaces. A. MARONI : Dimensions of the linear series of minimum order containing partially, without fixed residue, a given complete linear series. A. MASOTTI : The transversals of an isothermic system. W. STEPANOFF : Levi-Civita's problem concerning mean movement. A. TONOLO : Integration of the Maxwell-Hertz equations in uniaxial crystalline media. J. C. VIGNAUX : Total summability by Borel's method. Various conditions for the growth of the general term of a Borel summable series if it is to become totally summable, are considered. M. HAIMOVICI : A mechanical interpretation of Levi-Civita's parallelism. R. EINAUDI : (1) Reduction of the rank of canonical systems. (2) Forbidden lines due to nuclear spin. The theoretical determination of the intensity of the lines of a bivalent element corresponding with the passage from the term $^1S_0$ to the terms $^3P_2$ and $^3P_0$ is discussed. L. PINCHERLE : Intensity of the X-ray line spectrum of tungsten. Use is made of Dirac's relativistic auto-functions, calculated by the Thomas-Fermi statistical method, to calculate the relative intensities of the K and L tungsten lines more accurately than has been previously done. G. R. LEVI and D. GHIRON : Amorpho-crystalline transformations of arsenic and antimony. With arsenic, this transformation is accelerated by various catalysts, hydriodic acid being especially active. No transformation point exists and the change may be effected at 180°, which is lower by 90° than the lowest temperature hitherto recorded for the process. Antimony is obtained amorphous in presence, and crystalline in absence, of its chloride. Amorphous and explosive antimony are one and the same substance, which changes into the crystalline form, in absence of catalysts, between 250° and 100°. All the bismuth preparations examined proved crystalline. FL. G. ELISEI : Observations on the ontogenesis of the ligneous sieve tissue in *Mesembrianthemum*. B. BORGHI : Trypanosomiasis and avitaminosis (1). Rickets and *Trypanosoma Lewisi*. This trypanosome multiplies equally well in rats on normal diet and in those on rachitogenic diet. In rachitic rats it develops an indirect pathogenic action, aggravating the symptoms due to the deficient diet. A. FOÀ : Action of radium emanation on single cells or groups of cells. At the ordinary temperature, radium emanation apparently causes no cellular changes in the fibroblasts or myoblasts of the heart and skeletal muscles of hen's embryo, but at 38° marked modifications are produced. The phenomena are regarded as due principally to the α-rays and only partially, if at all, to the β- and γ-rays. LUISA POZZI : Proteolytic enzymes in the organs of scorbutic guinea-pigs. In scorbutic guinea-pigs the normal enzymic activity of certain organs (liver, kidneys, muscles) on *l*-leucylglycine is maintained, but the activity of the catepsic proteinases of the kidneys and especially of the liver is enhanced. L. VOLTERRA D'ANCONA : New aspects of the plankton of Lake Nemi.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 19, 389–475, April 15). HARLOW SHAPLEY : On the distribution of galaxies. Photographic plates taken with the Bruce 24-in. refractor now provide data of about one hundred thousand faint external galaxies. The present survey goes to magnitude 18·2 and again emphasises the greater richness of the northern galactic hemisphere. ALAN W. C. MENZIES and DONALD A. LACOSS : Influence of intensive desiccation on certain physical properties of benzene. Glass apparatus was used, so constructed that in the completed apparatus superheating could not occur; capillaries were avoided, no mercury or stopcocks were present, the whole could be strongly heated and it could be charged under dust-free conditions. The maximum rise of boiling point observed, practically stationary after twenty months, was 2·2°, under dust-free conditions at about atmospheric pressure. TH. DOBZHANSKY : On the sterility of the interracial hybrids in *Drosophila pseudo-obscura*. These hybrids are partially fertile females and completely sterile males. The latter is due to profound disturbance of spermatogenesis, including failure of chromosome pairing at meiosis. CLYDE E. KEELER and W. E. CASTLE. A further study of blood groups of the rabbit. The agglutinogens are present in newborn rabbits and even in embryos. They do not pass through the placenta, whereas the antibodies (agglutinins) do. They are gene-determined mutational characters inherited in Mendelian fashion. Agglutinins are not inherited characters. SEWALL WRIGHT : (1) Inbreeding and homozygosis. A mathematical discussion using the method of path coefficients for the case of sex-linked genes. (2) Inbreeding and recombination. CHESTER STOCK : Hyænodontidæ of the Upper Eocene of California. A. S. ROY : The effect of helium on the continuous and secondary spectra of hydrogen. The lines of the triplet system are increased in intensity relative to the singlet system and the continuous spectrum is stronger. This is considered to be due to the limitation of electron velocities by the helium. J. C. HUDSON and H. G. VOGT : K series spectrum of tungsten. The apparatus used was a General Electric Pyrex tube working at constant potential difference (165 kv., 8 ma.), and a calcite crystal ; distance from axis of spectrometer to photographic film about six metres. An evacuated steel tube is between the first slit (0·2 mm. × 30 mm.) and the crystal. β- and γ-doublets are revolved and the wave-length of the δ-line measured. JESSE DOUGLAS : An analytic closed space curve which bounds no orientable surface of finite area. JOSEPH MILLER THOMAS : Regular differential systems of the first order. W. SEIDEL : Note on a metrically transitive system. G. C. EVANS : Application of Poincaré's sweeping-out process. O. VEBLEN : Geometry of two-component spinors. GEORGE D. BIRKHOFF : Correction to the paper on some remarks concerning Schrödinger's wave equation.

Forthcoming Events

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

Saturday, September 9

At 8.0 p.m.—Prof. Julian S. Huxley : "Ants and Men" (Public Lecture at Edward Wood Hall).

Monday, September 11

At 10 a.m.—The Right Hon. Lord Meston : "Geography as Mental Equipment" (Presidential Address to Section E).

Prof. F. E. Lloyd : "The Types of Entrance Mechanisms of the Traps of *Utricularia* (including *Polypompholyx*) (Presidential Address to Section K, at Vaughan College).

At 5.30 p.m.—Sir Richard Gregory, Prof. W. J. Pugh, Prof. W. B. Brierley, Dr. Allan Ferguson, Prof. J. L. Myres, Sir Josiah Stamp. Symposium on "Cultural Value of Science in Adult Education" (Open to the Public).

At 8.15 p.m.—Prof. J. F. Thorpe : "The Work of the Safety in Mines Research Board" (Evening Discourse at Lancaster Hall).

Tuesday, September 12

At 10 a.m.—Mr. J. L. Holland: "The Development of the National System of Education" (Presidential Address to Section L).

IRON AND STEEL INSTITUTE, Sept. 13–15. Annual Meeting at Sheffield.

WOMEN'S ENGINEERING SOCIETY, Sept. 15–18. Eleventh annual conference at Crosby Hall, Cheyne Walk, London, S.W.3.

Official Publications Received

GREAT BRITAIN AND IRELAND

Institute for Research in Agricultural Engineering : University of Oxford. A Rapid Method for Measuring the Moisture Content of Wheat. By W. H. Cashmore. Pp. 24. (Oxford.) 1*s*.

Seale-Hayne Agricultural College, Newton Abbot, Devon : Department of Plant Pathology. Pamphlet No. 40 : Ninth Annual Report for the Year ending September 30th, 1932. Pp. 43. (Newton Abbot.)

Air Ministry : Aeronautical Research Committee : Reports and Memoranda. No. 1452 (T. 3126) : Drag and Pressure-Distribution Experiments on Two Pairs of Streamline Bodies. By C. N. H. Lock and F. C. Johansen. Pp. 19+4 plates. 1*s*. net. No. 1520 (T. 3319) : Air Torque on a Cylinder Rotating in an Air Stream. By Dr. A. Thom and S. R. Sengupta. Pp. 7+8 plates. 6*d*. net. No. 1536 (Strut. 123) : Effect of Stiff Ribs on Torsional Stiffness of Wings. By Dr. H. Roxbee Cox and D. Williams. Pp. 18. 1*s*. net. No. 1422 (T. 3139, 3300, Spin 114) : Experiments on the Hawker Hornbill Biplane. Part 1, by S. B. Gates, A. Ormerod and R. A. Fairthorne ; Part 2, by A. V. Stephens ; Part 3, by H. B. Irving and A. S. Batson. Pp. 19+12 plates. 1*s*. [illegible]*d*. net. No. 1512 (T. 3330) : Effect of Tractor Airscrew on Body-Wing Interference. By E. Ower, Dr. R. Warden and L. J. Jones. Pp. 34+13 plates. 1*s*. 9*d*. net. No. 1535 (T. 3375) : Simplified Presentation of the Subject of Spinning of Aeroplanes. By H. B. Irving. Pp. 32+2 plates. 1*s*. 9*d*. net. (London : H.M. Stationery Office.)

OTHER COUNTRIES

Ministerio da Agricultura : Directoria Geral de Pesquisas scientificas : Instituto de Meteorologia, Hydrometria e Ecologia agricola. Contribuição para o estudo hydrometrico do rio parahyba do sul. Pelo F. E. Magarinos Torres. Parte 1. Pp. iv+81+154+36 plates. (Rio de Janeiro : Ministerio da Agricultura.)

Occasional Notes of the Hong Kong Horticultural Society. Edited by G. A. C. Herklots. No. 3 : A Gardening Vocabulary in English and Chinese. Pp. iv+29. (Hong Kong.) 1 dollar.

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