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## Popularisation and Archæology

A REFERENCE to the widespread interest among the general public in the results of research in the past history of mankind has become almost a commonplace of comment on archæological matters; but few go on to inquire why such an interest should be so marked at the present day, in contrast with, say, the period preceding the War, when, for example, Sir Arthur Evans was engaged in his epoch-making investigations in Minoan Crete. To say that excavations at Ur, in Egypt, or Palestine have had a better Press in the last ten or twelve years than was given to archæology in the ten years before the War, merely begs the question. The popular Press, to which this diagnosis applies particularly, is, in this matter, a symptom of its readers' tastes rather than the cause. It follows rather than guides; but in a mistaken judgment on the situation it is prone to a sensationalism that is superfluous, in so far as its object is to stimulate an interest which already is anxious to be informed.

Actually, it is not the sensational but the familiar combined with the remote in the study of prehistory that in the long run captures the imagination of the plain man. A flint implement, be it five or fifty thousand years old, means no more to him than a useless lump of stone. Everyone, however, at some time in his life has handled a knife, a chisel, or a saw, and when the purpose of the flint implement has been explained to him, or better, when he has handled it for himself, he realises the nature of the problems which confronted his remote ancestors, and the differences in the means at his disposal for dealing with the same or similar problems. In other words, he has grasped perspective in the growth of civilisation, and also its continuity. Henceforth his attitude to the past will have undergone a fundamental change: his interest has been permanently aroused.

If it has been that in the development of archæological studies since the War attention has been directed more particularly to the interpretation of the results of excavation in terms of affiliation, to tracing the movements of races and cultures, inferring racial and cultural contacts and marking consequences in the modification or development of material culture, it is equally true that a more intense application of the results of the sister studies of geology and geography to the problems of archæology—in itself no new thing—also has produced developments which have been of the

first order of importance in stimulating research in the field and in the co-operative elaboration of theory.

The distribution map has long been a familiar implement of the archæologist's laboratory. Expertly interpreted, it has been made to tell the story of trade route and racial movement; but interpreted in the light of geology and geography, it becomes more eloquent still. Dr. Randall-MacIver, in his recent presidential address to the Section of Anthropology of the British Association, discussed the results of recent research on these lines in narrowing down the limits of search for a man's earliest ancestors and in the interpretation of the distribution of the earlier products of human industry. Even more fruitful have been Dr. Cyril Fox's researches in demonstrating how geology, geography, and palæobotany can in combination answer the questions posed by the archæological succession in showing how it came about that certain events fell out where they did, and why development should have taken certain lines. The methods of his book, "The Archæology of the Cambridge Region" (Cambridge, 1923), were demonstrated on the broader canvas of Britain as a whole in his lecture before the recent International Congress of Prehistoric Sciences (see NATURE, Aug. 13, p. 247), when he showed how two distinct geographical areas in Britain reacted differently to intrusive culture, and traced the development of the Briton from uncivilised to civilised with the gradually acquired control of his environment, as shown by the movement of settlement from one type of land to another, and followed the transfer of trade from the line Solent–Salisbury Plain to the Thames basin.

Archæological investigation on this scale is essentially a matter of synthesis of the observations of a number of individuals. It is interesting to note how archæological investigation has been assisted since the War by two Government departments acting in concert and on a scale that would have been a practical impossibility for private effort—in one instance more or less unofficially as a by-product of official activities, in the other as a part of official duties. These departments are the War Office, of which the course of training for the Royal Air Force has afforded opportunities for archæological observation and photography, and the Ordnance Survey, which now carries on its establishment an Archæological Officer.

No single recent development in archæological method has attracted so much public attention as the discovery that it is possible to discern from the air archæological remains of which the presence cannot be detected on the ground. Of the many ancient monuments and remains of which knowledge is due to this method of observation, Woodhenge in Wiltshire is the most important and the most interesting; but the utility of air observation is far from ending there, and the magnificent panoramic series of views of Wansdyke shown at the recent exhibition, illustrative of British archæology in the field, at the London Museum (see NATURE, Aug. 6, p. 196) demonstrated its value not only as a means of record, but also as an aid in the preparation of accurate plans and maps. Those who became familiar with the use of air photographs during the War will appreciate the value of this method of study in arriving at the purpose and plan of earthworks and other forms of enclosure.

The work of the Ordnance Survey has for long been concerned with the record of ancient monuments as part of its normal duties. Indeed, the Survey preserves at its office at Southampton a proof sheet of the original one-inch map of Wiltshire, made more than a century ago, which bears the manuscript archæological corrections of Sir Richard Colt Hoare. Since the first appointment of an Archæological Officer thirteen years ago, its activities in this direction have been much extended, especially in adding to the list of known monuments, both under- and over-ground. More widely known, though still perhaps less than it deserves, is the excellent series of archæological studies of which the first was the map of Roman Britain issued in 1922, Mr. O. G. S. Crawford's "Archæology from the Air" coming later, and the latest addition being the "Map of Neolithic Wessex",* an adaptation of the Quarter-Inch Ordnance Map, Sheet 11, to show the distribution of the long barrows, circles, habitation sites, and flint mines, preceded by thirty-five pages of commentary and schedules of monuments.

Without entering into a discussion of technical detail, it may be said that the interest of the Wessex map, from the point of view of its general educational value, lies in the combination of archæological, geographical, and geological detail, which shows the monuments as they lie in relation to the natural environment of the neolithic period, and at the same time invites contrast and comparison with conditions as they are to-day. A glance at the map as a whole, keeping in view geological formation, shows why settlement was in the main confined to

* Map of Neolithic Wessex. By Ordnance Survey. Southampton, 1932. 4s. net.

certain open spaces. Neolithic man avoided the forest areas, as here reconstructed, and the open heaths, in favour of the broad shallow valleys of the downs, where there were perennial streams, pasture for his sheep, and land suitable for crude cultivation. Here, too, in waterlogged clays and the narrowed strips of forest and their relation to settlement may be seen why communications followed certain lines, while along others traffic was delayed until Roman or even medieval times.

In the compilation of the map of Wessex, the Ordnance Survey was assisted by a body of voluntary helpers. Archæology is at present fortunate in having at its disposal a number of highly skilled unpaid workers; but even so, archæological fieldwork is normally an expensive undertaking. In these days of economic stress, expenditure which depends for its funds upon assistance from public subscription must justify itself by its works and not by faith. Enough has been said to support the view that the exposition of the results of archæological research to be popular need be neither unscientific nor sensational. An archæology that can continue to stimulate the interest of the general public in the past history of mankind need have no fear for the future and is fully justified of its children.

## Philosophy Looks at Science

(1) *Philosophy of the Sciences: or the Relations between the Departments of Knowledge.* By the Rev. F. R. Tennant. Pp. ix + 191. (Cambridge: At the University Press, 1932.) 6*s*. net.

(2) *Philosophical Aspects of Modern Science.* By C. E. M. Joad. Pp. 344. (London: George Allen and Unwin, Ltd., 1932.) 10*s*. 6*d*. net.

(3) *The Approach to Philosophy.* By J. F. Wolfenden. Pp. 236. (London: Edward Arnold and Co., 1932.) 7*s*. 6*d*. net.

MANY criticisms of modern science and of scientific workers to-day relate to their excessive specialisation and the defective sense of values which specialisation is apt to engender. The philosophic views expounded in these three books illuminate the underlying causes of such defects and are of further interest from the picture they give of science as viewed and appraised by the philosophers.

(1) In the "Philosophy of the Sciences" the relations between the departments of knowledge are discussed and attention is directed to various dangers attending specialisation or, as Dr. Tennant terms it, "departmentalism". The one aspect of the facts on which the specialist concentrates is sometimes treated as if it were the only aspect, and again, disparities or discontinuities are assumed where knowledge of other fields would indicate continuity or compatibility. This danger is the more serious when experts in one sphere of knowledge make incursions into other spheres in which they are not equally at home, and thus are apt to propagate erroneous beliefs. Dr. Tennant has obviously in mind mathematical and physical exponents of the theory of relativity, whose theories are criticised in detail from a similar point of view by Mr. Joad.

Dr. Tennant observes wisely that "the history of science forewarns us, and the philosophy of the sciences can forearm us, against confounding utility for the purpose of an abstract and special science with significance for the interpretation of knowledge in its comprehensiveness, as to the world, in its concreteness". Accordingly, Dr. Tennant argues for a philosophy of the sciences which shall be able to undertake this task of mediation. By a philosophy of the sciences we are to understand not a science of the sciences, as suggested by Spencer, or a classification of them according to their subject matter, or even a comprehensive survey attempting to sum their generalisations, but a sifting of the methods and products of the special sciences which will enable us to grasp the main features of the world and to relate them as parts of one whole. The resultant systematic arrangement of the sciences according to their dependence one on another is what the author understands by a philosophy of the sciences.

Essentially, therefore, we have in Dr. Tennant's book an attempt to capture real values, the absence of which has doubtless much to do with the present chaotic condition of the world under the impact of applied physical science. To this defect Dr. Tennant obviously refers when he reminds us that "between science and the world stands human nature. . . . The world is knowable only to an extent determined by the range of human faculties and only in a manner that is conditioned by their distinctively human nature." From this we are led to the somewhat unorthodox view—which, however, is supported by Dr. Charles Singer's address to the second International Congress of the History of Science and Technology last year—that history, in the wider sense, takes the first place in the systematic order of the departments of knowledge dealing with what is known, as distinct from our knowing, its matter determining all the other sciences, and it also

prescribes the method which philosophy, as distinct from a pure science, must follow.

In support of this view, it is urged that all sciences begin with the historical and empirical facts as they are constituted at the level of philosophical organisation denoted by common sense, and that philosophy, which aims at seeing things whole and as a whole, cannot take its departure from sciences which owe their very existence to leaving out much of the stuff of knowledge because it is not scientifically manageable by them or is irrelevant to their business. The relation of history to science is discussed, and the claims of history to be a department of knowledge, although it is not an experimental science, are based on its being more than a mere inventory of items of fact; for it involves a critical sifting of its primary data, and the process of selection with which historical research passes into historiography is parallel with processes which occur in natural sciences in evolution and survival of individual hypotheses or theories.

Psychology, theory of knowledge, and history indeed reveal the presuppositions of physical science and set the bounds to its scope and functions, and only when its relations to them are appreciated can the true nature of scientific knowledge be appreciated. Dr. Tennant carries his arguments further and discusses the broad differences between theology and science, claiming that once it is recognised that all knowledge of the actual world is pre-eminently interpretative, the concepts and categories required by the historical sciences can be involved with as much right as the fewer and more formal categories by the pure sciences.

(2) Mr. Joad's discussion of philosophical aspects of modern science is more from a metaphysical point of view, but his criticism of the theories of modern physicists, although more detailed, is in general similar to Dr. Tennant's and leads him to a point of view not dissimilar. The conceptions of the physical universe sponsored by modern science are changing with extreme rapidity but are all extremely remote from the world of common sense, so that the question of their real status and other strictly philosophical questions arise. It is the business of philosophy to correlate the evidence collected by the special sciences and to try to fit it into a coherent scheme of the universe as a whole. Moreover, the vision of the artist, the religious consciousness of the saint, and the day-to-day experience of the plain man are equally facts of which philosophy must take cognisance. This urgent task of correlation and humanisation demanded by the changing conceptions of modern physics is not made easier by the increasing disposition of men of science to enter the domain of philosophy, and Mr. Joad reviews in detail the views of Eddington, Jeans, and Bertrand Russell in relation to a theory of scientific knowledge which forms the main part of the book. The philosophies of the universe based upon the interpretation of modern physics are open to objection because they regard the familiar world of sense experience as not objectively real but in some sense a product of the observer's mind. Similarly, they regard the world of modern physics as not objectively real but in some sense a product of the scientific worker's reading; and they despise brute collections of given fact and seek to analyse them away into mind or law. Starting from certain premises—what the plain man perceives and what science has discussed—they reach conclusions which suggest that the premises are misleading, in the sense that the plain man does not perceive what he thinks he perceives, and the discoveries which science has made do not truly represent the nature of what is.

These mistakes, Mr. Joad suggests, arise not from false science but from a false theory of knowledge, and he considers that eminent men of science misconceive the nature of the act of knowing and the nature of its relation to the object known. The most important part of the book is, however, not its attempt to clear up the muddle of the relation of the world of science and of common sense, but its discussion of the question of values, including the moral, æsthetic, and religious values. Religion and science are each a legitimate avenue for the exploration of reality, but of different orders of reality, and in Mr. Joad's view the researches of the scientific worker equally with the perceptions of the plain man, the moral consciousness of the good man, the sensitivity of the artist, and the religious experience of the mystic are revelatory of reality. Philosophy in its endeavour to understand every aspect of the universe is thus both a bar to which the various methods of obtaining information about the universe may be called to give an account of themselves, and also a clearing-house in which different forms of experience may be pooled. Mr. Joad's sympathetic treatment of science lends the greater force to his criticisms and exposition of the limitations of scientific method, and he wisely reminds us: "Science is still a new thing and man is still inapt in its use".

(3) Mr. Wolfenden writes an eminently readable introduction to philosophy, in which its relation to science is discussed in a vein very similar to that

of Dr. Tennant and Mr. Joad. There is very little attempt to make a personal contribution to a solution of the problems which vex mankind, but this rapid and concise review of the territory of philosophy should be of real assistance to scientific workers who are anxious to gain a sense of the value and position of science and its methods. Without such perspective, science can never take its natural place as part of the life of either the individual or of the nation, and the absence of effort to attain that perspective is commonly due at least as much to mental laziness as to the erroneous assumption frequently made by scientific workers, that the scientific method is the only way of finding out anything about anything and necessarily opposed to any other method or direction of inquiry. In addition to differentiating carefully between science and philosophy and their respective methods, Mr. Wolfenden makes a bold claim for philosophy as constructive.

## Internal Combustion Engines

(1) *Internal Combustion Engines.* By Prof. J. A. Polson. Pp. vii + 475. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1931.) 25*s.* net.

(2) *Automobile Engines in Theory, Design, Construction, Operation, Testing and Maintenance.* By Arthur W. Judge. (Motor Manuals : a Series for all Motor Owners and Users, Vol. 1.) Second and revised edition. Pp. 220. (London : Chapman and Hall, Ltd., 1931.) 4*s.* net.

(3) *Principles and Problems of Aircraft Engines.* By Minor M. Farleigh. Pp. xi + 277. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1931.) 15*s.* net.

(4) *Heavy-Oil Engines of Akroyd Type : being Developments of Compression-ignition Oil Engines, including Modern Applications to Land Purposes, Marine and Airship Propulsion, and Railway Traction.* By Prof. William Robinson. Pp. xv + 142 + 16 plates. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1931.) 7*s.* 6*d.* net.

A CENTURY ago there were neither gas nor oil engines ; to-day they are counted by the tens of millions. Indispensable for the navigation of the air, the internal combustion engine has effected a revolution in road transport, it has successfully challenged the supremacy of the steam engine at sea, it has found its way on to the railroads, and it has for many years been a valuable ally of the steam engine and the water engine for the production of power for public and industrial use. In these circumstances, it is not surprising that the literature dealing with it is becoming very extensive, and that books are written regarding it, for many purposes and to suit many needs.

(1) One class of such books is represented by Prof. Polson's textbook, written for engineering students who know something about thermodynamics and the construction of internal combustion engines, but who stand in need of a general treatise on the theory and practice of this branch of engineering. There are chapters on the thermodynamics of the Otto and Diesel cycles, gaseous fuels, blast furnace gas engines, engines for motor cars, aeroplanes, ships, and power houses, and on the various appurtenances of such engines. The engines dealt with are mainly of American manufacture, and the book includes a chapter on the testing of internal combustion engines with the code of the American Society of Mechanical Engineers.

(2) and (3) Of an entirely different character are the books of Mr. A. W. Judge and Mr. M. M. Farleigh. In these there are no mathematics and little thermodynamics, but a great deal suitable for those who have to run and maintain the engines of motor cars and aeroplanes. After chapters on the combustion process and the petrol engine, Mr. Judge deals with types, lubrication, cooling, testing, maintenance, and timing of automobile engines of British make ; and there is no owner or driver of a motor car who will fail to find something of interest or value in what he says.

Mr. Farleigh's book is written in non-technical form, so far as the subject allows, and is primarily intended for the licensed mechanic, the licensed pilot, the operator, and the student who desires to qualify as a mechanic or pilot. One informative chapter is that on "Trouble Shooting". Men for such work, he says, must be "men of keen intellect, imaginative, resourceful, enthusiastic, and above all wholly conscious of the importance of their work". His list of "unusual troubles" is evidence of the importance of small things, while his "cases" show how difficult it is even for experienced men to diagnose the trouble quickly.

(4) The fourth of these volumes under notice, we imagine, has been written with a desire to see that full credit is given to an inventor, Herbert Akroyd Stuart, whose name should be as familiar as that of Diesel. Stuart was born in 1864 and died in 1927 ; Diesel was born in 1858 and died in 1913. Their pioneering work on oil engines was contemporary but independent. The engineering world has made

great use of the work of both, and practically all heavy-oil engines of to-day are descendants of the original Stuart or Diesel engines. Both were compression-ignition engines and in both engines the oil fuel was injected into the cylinder in a spray, but whereas Diesel for this purpose used highly compressed air, Stuart used 'airless-injection' as it has now been termed. Most modern oil engines use airless-injection. Not a little confusion has been caused by the Stuart engine being called an Akroyd engine, the only instance, we are aware of, of an inventor's Christian name and not his surname being given to his invention. Many engineers are fully conversant with Stuart's work, but others are not, and in the index to Prof. Polson's book is found neither the name Stuart nor Akroyd.

Stuart's work should certainly be known to American students, for the Hornsby-Akroyd engine was introduced into the United States so early as 1893, at a time when the Diesel engine was still being experimented with in the shops of the Maschinenfabrik Augsburg, Nürnberg (now known as "M.A.N."), and of Messrs. Krupp. Prof. Robinson knew Stuart intimately, and his book is not only an up-to-date review of heavy-oil engines of Akroyd type, but also an authoritative history of the subject.

## Magnetism and Quantum Mechanics

*The Theory of Electric and Magnetic Susceptibilities.* By Prof. J. H. Van Vleck. (The International Series of Monographs on Physics.) Pp. xii + 384. (Oxford: Clarendon Press; London: Oxford University Press, 1932.) 30*s.* net.

THE development of a scientific theory involves the interplay of observation, reasoning, and imagination. Experimental results are co-ordinated by generalisations of ever-widening scope through those imaginative leaps which place scientific method, as a whole, outside the scope of strict logic. The generalisations can then be regarded as premises on which may be built a deductive scheme, in which logical consistency is of paramount importance—logical consistency, in theoretical physics, appearing as mathematical rigour. The reasoning, however, is barren, scientifically, unless the deductions are confronted, as 'predictions', with experimental findings. If there is continued agreement, the premises take rank as a scientific theory.

Quantum mechanics, though it may not yet have reached its final form, has developed quite normally along these lines. The experimental findings with which it has been most prominently associated, both in its quasi-inductive and deductive aspects, have been those in the field of spectroscopy. Phenomena other than the purely spectroscopic, however, played an important part in the building up of the theory; and now that general postulates have been reached the range of application of which in connexion with spectroscopy has been amply demonstrated, interest centres in the development of their consequences for application in other fields. "A theory is most 'physical'", Van Vleck observes, "when it permits the calculation of a large number of experimentally observable quantities in terms of a few fundamental postulates", and this point of view characterises his presentation of the central theme of his book—the quantum-mechanical theory of magnetic and electric susceptibilities.

The book opens with four chapters dealing with classical theory. An admirable discussion is given of the relation between the macroscopic and microscopic field equations; the Lagrangian and Hamiltonian functions appropriate when electric and magnetic fields are present are derived; and the relevant results of statistical mechanics are outlined. These preliminaries lead up to the classical derivation of the Langevin-Debye formula for susceptibility due to polar molecules. The experimental results on dielectric constants and refractive indices are considered in a well-documented chapter with reference to the determination of the permanent and induced molecular moments. The analysis of these results on a classical theory basis is justified because the new quantum mechanics restores the validity of many of the classical results for electric susceptibility. The Langevin theory of magnetic susceptibility, however, rests on the classically unjustifiable assumption of molecules having 'permanent' magnetic moments, and a rigorous application of classical principles leads to the prediction of zero susceptibility, a result which is clearly explained. The difficulties and inadequacies of the old quantum theory of magnetic susceptibility are then discussed.

Quantum mechanical theory, including the perturbation 'machinery', is developed with all necessary detail, particular attention being paid to the relation between the wave and matrix methods, a combination of which, in Van Vleck's hands, has proved a powerful weapon in dealing with the problems under consideration. Application is made to the dielectric constants and diamagnetic susceptibilities of atoms and ions, the paramagnetism of free atoms and rare earth ions, the para- and diamagnetism of free molecules, and the para-

magnetism of solids, particularly salts of the iron group. Heisenberg's theory of ferromagnetism is then discussed, and also the theory of the magnetic effects of 'free' electrons. Finally, a brief summary is given of related optical phenomena.

The mathematical difficulties which arise when the attempt is made to obtain numerical results, other than the roughest approximations, from the application of quantum mechanical theory even to relatively simple systems, is well known. Van Vleck's treatment is characterised by the boldness and thoroughness with which these difficulties have been met. This is particularly marked in his own considerable contributions to the subject—as in connexion with the temperature dependence of the susceptibility of nitric oxide, with the paramagnetism of the rare earth ions (which cleared up in a most satisfying manner the discrepancies between the experimental values and those given by the approximate theory), and with the susceptibility of hydrogen. The theory of the magnetic, and also electric, susceptibilities of media which can be treated as consisting of free atoms, ions, or molecules can now be presented as a consistent, rounded whole.

For more extended application to solids generally, it is necessary to consider the effect of interactions, of which one type is the 'interchange' interaction of Heisenberg's theory of ferromagnetism. A further considerable advance has been made by Van Vleck in showing that, owing to interatomic forces, there may be a partial or complete 'quenching' of the orbital moment effect, this giving theoretical justification to a previously suggested explanation of the peculiar paramagnetic characteristics of salts of the iron group.

Van Vleck's book, owing to the inherent difficulties of the subject matter, will not be found easy reading, especially by non-mathematical readers. Its peculiar value lies in the skill and completeness with which details are filled in; it is admirably lucid, and the reader is, as it were, carried on by Van Vleck's own enthusiasm for clearing up minor as well as major points. The footnote references are numerous, and work other than that of the author receives adequate discussion. There is throughout a welcome absence of dogmatism and of that suggestion of finality which is often so irritatingly conveyed in theoretical works; moreover, excellent reviews are given of experimental results. The book is a most valuable contribution to the study of magnetic and electric susceptibilities and to quantum mechanical theory.

E. C. S.

## Applied Statistics

(1) *The Methods of Statistics: an Introduction mainly for Workers in the Biological Sciences.* By L. H. C. Tippett. Pp. 222. (London: Williams and Norgate, Ltd., 1931.) 15*s.* net.

(2) *The Combination of Observations.* By David Brunt. Second edition. Pp. x+239. (Cambridge: At the University Press, 1931.) 12*s.* 6*d.* net.

STATISTICS is a subject which has grown very rapidly during the last twenty years, and it is therefore inevitable that the textbook should tend to depart more and more from the traditional form. The emphasis has somewhat changed, and the need to-day is to cater for the growing public that desires to know something of the practical tests that may be applied to the numerical results of experimental work, in which the sample is not usually very large. In particular, the present-day biological worker is characterised by a thirst for knowledge of the *results* of statistical research, combined with a stoical indifference to the mathematics used to bring about these results. The sampling problems that serve as a basis for the practical tests are of some mathematical difficulty; nevertheless, they are of fundamental importance, and the ideas tend to be introduced at a much earlier stage than has hitherto been customary. If the reader is prepared to take the mathematics on trust, then certainly the tests he is asked to carry out, generally with the aid of tables, are not difficult.

(1) The pioneer textbook in the new form was R. A. Fisher's "Statistical Methods for Research Workers", in which not only was much new matter introduced to the consideration of teacher and student, but the method of presentation was also radically altered. Where difficulty has occurred, it has usually been due to an inability on the part of the reader to appreciate the subtleties of the argument, through ignorance of the theory on which it is based. On the whole, however, the biological worker is getting what he wants, and Tippett's "Methods of Statistics" is to be welcomed as another manual of statistics in the new style, which, within the compass of a little more than two hundred pages, covers a very great deal of ground.

There is little in the way of practical tests that does not find a place, and the book will repay careful reading. The numerous examples are welcome, but could with advantage have been treated in greater detail, at any rate at the

beginning; unless the reader fully understands the nature of every step in the calculation, which should be made clear by the actual working, and not solely by reference to formulæ, he is liable to be brought to a full stop. In fact, a general criticism is that the cloven hoof of the mathematician is occasionally allowed to obtrude itself, and the reader, while spared the proofs of the formulæ, is nevertheless assumed to be an adept at the equally difficult (to him) question of mathematical symbolism.

We welcome the further attempt to standardise a satisfactory notation, but terms are used which are still novel, and it is all the more necessary, therefore, to define them precisely, and avoid through looseness of statement any suggestion of giving a different shade of meaning to words already in use. In particular, the ideas of *population* and *sample*, and the distinction between population parameters and the estimates of these derived from a sample, have so recently emerged from an obscurity that was often deepened by the use of an insufficiently distinctive notation that the greatest care is necessary in elaborating these ideas.

(2) Mr. Brunt's book, the first edition of which appeared in 1917, is of a more heterogeneous character. It is described in the preface as a manual of least squares. The theory of errors of observations is developed along standard lines, and the details of the adjustment of observations by the method of least squares is very full. In a series of supplementary chapters, which alone have been revised in the new edition, some attempt is made on one hand to amplify the earlier treatment of the theory of error for the benefit of the biometrical worker, the subjects chosen being alternatives to the normal law of errors and correlation; on the other hand, an excellent account is given of harmonic analysis and the periodogram.

In contrast to Tippett, the book appeals to the mathematical reader, although in actual fact the mathematics is never very profound. The heterogeneity, evident from a description of the contents, is emphasised by an unfortunate change of notation when passing from the theory of error proper to the studies more appropriate to the biometrician, and by the separation of the chapters on least squares from the study of multiple correlation, when the latter, in fact, follows naturally from the former.

It may be doubted whether it is desirable in a book of the size and character of this to enter into details of the fitting of the Pearsonian or other forms of frequency curves. A general idea only of this development can be given, and the practical details of fitting are not entered into. While it is desirable to point out that not all populations are normal in character, it is also true to say that few experimenters have data so ample that significant departure from normality is found to exist. It is thus possible to find a self-contained textbook like that of Tippett in which the assumption of normality is implicit throughout. Brunt's textbook cannot claim to be a manual of statistics; at the best, only selected portions of the subject are dealt with, and the book as a whole is of a character that must be becoming increasingly difficult to write in this age of specialisation.

The early examples on the reduction of observations would have been improved by a discussion of tests of goodness of fit, while the chapter on correlation deals rather lamely, for a book of a mathematical character, with the formulæ for the probable errors of the various constants, which are introduced without proofs and with no discussion of their limited applicability in general to problems of this kind. The book is, however, clearly written throughout and there is little in it that is obscure. It should continue to be of service to the class of student to whom it is addressed.

J. WISHART.

## Short Reviews

*An Introduction to Organic Chemistry.* By Prof. R. J. Williams. Second edition. Pp. xi + 585. (London: Chapman and Hall, Ltd., 1932.) 21*s.* net.

THE publication of a second edition of this book four years after its first appearance, coupled with the fact that during those four years it was reprinted four times, is eloquent testimony to its popularity among both teachers and students of organic chemistry. This success must be attributed to the manner in which the author has presented most of the material, the result being a connected and well-written story in which many of the more recent advances of knowledge are incorporated.

In the main, the scope of the work conforms to its title, but the book differs from many of the smaller books on general organic chemistry in that considerable space is devoted to electronic formulæ and to a discussion on the structure of benzene. The predominant and most commendable features, however, are the lucid explanations of reactions and an array of graphic formulæ in support of the verbal explanations. At the same time the book stimulates thought, and the resourcefulness of the student in applying his knowledge is put to the test at the end of each chapter by means of a judicious selection of problems.

In general, the treatment is adequate, sound, and

up to date, but the section on heterocyclic compounds, including the chapter on alkaloids, must be amplified in a future edition if it is to satisfy the requirements of many of those students for whom the book has been written.

*Le soleil.* Par Prof. G. Bruhat. (Nouvelle Collection scientifique.) Pp. xii + 240 + 16 planches. (Paris : Félix Alcan, 1931.) 20 francs.

PROF. BRUHAT has used a course of lectures given at the Sorbonne in 1930 as the basis of this book, but has eliminated to a great extent the mathematical treatment of his subject in order to reach a wider circle of readers. All who possess an elementary knowledge of physical sciences will find the book an interesting, clear, and up-to-date account of the present state of our knowledge of the sun, as well as of the instruments and methods used in attaining that knowledge. A considerable amount of this matter is not to be found in any English works of a similar nature, but the historical accounts are occasionally inadequate or even definitely misleading.

Problems concerning the internal constitution of the sun or its evolutionary history receive little or no attention, as being beyond the scope of the book ; apart from this, however, recent advances in observational methods, results, and theories form a prominent feature, and the whole supplies a good introduction to modern solar physics. The printing and paper leave much to be desired, and an index would have been a useful addition to the book. The plates are suitably chosen as representative of the subject matter and well reproduced ; they are bound together at the end, and consist mainly of photographs taken at the Meudon Observatory.

*A Manual of Determinative Mineralogy, with Tables : for the Determination of Minerals by means of 1. Their Physical Characters ; 2. Blowpipe and Chemical Properties ; 3. Optical Properties.* By J. Volney Lewis. Fourth edition, revised by Prof. A. C. Hawkins. Pp. ix + 230. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1931.) 18*s.* net.

WITH the exception of certain minor alterations, the fourth edition of Prof. Lewis's well-known " Manual " differs but little from the third edition published in 1921. Prof. Hawkins, in his revision, has effected a very considerable saving in space, amounting to 68 pages, mainly in the physical tables. Instead of repetition in the case of such minerals as fall into two classes, an effective system of cross references has been employed. Further, in the tables of blowpipe reactions, certain rare and relatively unimportant species such as jarosite, glaucodot, etc., have been eliminated.

A short section has been added on optical properties, mainly with the object of impressing on the student the importance of optical properties in the determination of minerals. Optical data are given for a few common minerals. In its revised form, this work remains an exceedingly useful and simple guide to the determination of minerals according to their physical properties and blowpipe reactions.

*Divorce : a Social Interpretation.* By Prof. J. P. Lichtenberger. (Whittelsey House Publication.) Pp. xii + 472. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1931.) 21*s.* net.

THE use of scientific method and the disuse of appeals to authority, whether ecclesiastical or other, are the leading characteristics of this book. The author first states the problem, which is the explanation, not the justification, of the present divorce situation. He then enters upon a historical and descriptive account of marriage and divorce from the earliest to modern times, with special reference to America. Then, after considering some explanations of the divorce ' trend ' which he regards as inadequate, he proceeds to develop his own lines of explanation. We think he begins badly by laying it down as an axiom that " divorce is an effect, not a cause ", since the disintegration of the marriage has taken place before the divorce. But easy divorce is surely one cause of light views of marriage, and therefore of easy virtue. Yet there is so much excellent material in the book that it must be accounted a serious contribution. The author's wide knowledge of the literature of the subject makes him extremely apt in quotation.

*A Naturalist in Brazil : the Flora and Fauna and the People of Brazil.* By Prof. K. Guenther. Translated by Bernard Miall. Pp. 400 + 32 plates. (London : George Allen and Unwin, Ltd., 1931.) 25*s.* net.

THIS is an admirably illustrated book on the flora and fauna of Brazil. It marshals the natural history of the country in an instructive manner, but we do not discover that the author has concentrated on any special problem or added much to our previous knowledge. His chapters on " The Mosaic of Colours " and " The Symphony of Voices " are attractive, while the variety of devices employed by parents for ensuring the survival of their young will attract many readers. This is a book invaluable to anyone who desires to visualise the country and its inhabitants, a pleasant ' Baedeker ' of Nature.

*The Sciences of Man in the Making : an Orientation Book.* By Edwin A. Kirkpatrick. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xv + 396. (London : Kegan Paul and Co., Ltd., 1932.) 15*s.* net.

IN the short compass of this volume, the author surveys the various sciences referring to man, from anthropology and ethnology to economics and politics, and from psychology to morals. No particular views are expressed, which belongs to the ' orientation ' type now so popular in the United States. The ' suggested readings ' at the end of each chapter refer almost entirely to American publications and authors. As a restatement of questions of methods relating to the study of mankind, however, the book makes enjoyable reading. T. G.

# The Growing Tree*

By Prof. J. H. PRIESTLEY

RECENT studies of the growth of the tree, helped by some new methods, have shown that each season this growth begins in the bud, whence it spreads downwards over the rest of the tree. The discovery of this fact may influence, in quite a surprising way, our understanding of the tree—its form, its structure, and its vital functions.

## LONGITUDINAL AND RADIAL GROWTH

The plants we call trees clearly have certain characteristics in common, though the botanist does not group them together in one class. They produce new crops of leaves periodically, but usually they do not flower for a number of years. Green leaves add to the substance of a plant, whilst flower and fruit exhaust it, so that the tree continues to gain in size and weight for many years. Much of this added weight is wood and bast, of which new increments are added each year, on the outer surface of the wood and the inner surface of the bast, by the activities of a growing tissue lying between wood and bast, called the cambium.

Each new crop of leaves is not borne directly upon the old wood but on new shoots which emerge from the buds. These new shoots grow in length, whilst the old branch system thickens but grows no more in length. The two growth processes do not seem connected at first sight, but the tree will only be understood when we realise that they depend very closely upon one another. During this year a new method of studying radial growth has been developed by which it has been possible to show how closely extension growth and radial growth are connected.

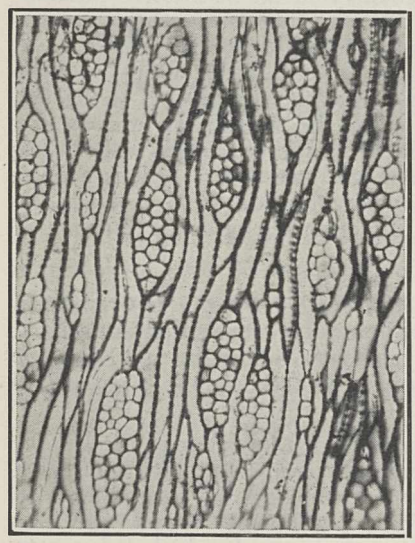

FIG. 1.—Photomicrograph of a strip of new tissue scraped from the surface of the old wood in ash. These cells have been formed by division of the cambial cells. ×100.

When the cambium recommences growth, its cells become very liquid, and the bark together with the bast easily peels from the wood, or, as we say, the bark 'slips'. The new soft plastic tissues can then be scraped off the hard old wood surface with a sharp tool, and long strips of tissues, newly formed from the cambium, can be obtained with the utmost ease. It has thus been possible to show that these tissues are first formed beneath the buds as they commence to grow, and that the cambial activity spreads thence always downwards—down the branches and down the trunk. These strips of tissue, as shown in Figs. 1, 2, and 3, exhibit beautifully under the microscope the structure of the new cells just formed from the cambium, and their study should reveal many new and interesting facts as to the changes these tissues undergo as they are transformed into wood.

FIG. 2.—Photomicrograph of strip similar to that in Fig. 1, taken from spruce. Note the great length of the cells. ×133.

This new method has revealed most clearly the dependence of radial growth upon the buds. Cambial activity only begins after the buds commence growth, and cambium growth always spreads downwards from the base of the buds. We now know why, when pruning, the knife should cut across the stem just above a bud. Thus no piece of stem is left projecting above the topmost living bud. When such a piece of stem is left, the cambium in it never grows again, and this piece of stem withers to an unsightly snag.

The growth of buds depends very much upon light. The forester therefore plants his trees close together, so that the lower, side branches are shaded and their buds soon cease to grow. These branches then grow no more in thickness, lose their water, and become dry. On such withered branches the bark does not 'slip' but clings close, whilst on the main stem around their bases it is being pushed outwards by the growth of the cambium. The bark is thus thrust into sharp folds around the base of each withered branch, and the strain increases with continued growth until the dry branch is snapped off. Thus the lower dead branches are swept off, new wood still forms each year, and the stumps of these branches are gradually buried in the wood of the growing trunk, not to be seen again until they appear as knots in planks cut from the trunk. On the surface of the tree, the folds of bark may

* Substance of the presidential address to Section K (Botany) of the British Association at York on Sept. 5.

persist for many years, indicating the presence of these branch stumps, as the ripples on the pond tell of the stone sunk in its depths. The folds may be studied and recorded very simply, by placing paper over the bark and rubbing it with cobbler's heel-ball.

### Softwood and Hardwood Trees

Branch systems, and the knots they leave in the timber, are rather different in two different tree types, the broad-leaved hardwood and the needle-leaved softwood. The former belong to the class of Dicotyledons, whilst the softwood belongs to the conifers.


Fig. 3.—Photomicrograph of the new tissues, derived from the cambium in sycamore. Through the new tissues, are developing vessels (*a*) which are in communication with the leafy shoot above. ×100.

The softwoods have usually a very regular 'Christmas tree' habit of branching, a new whorl of branches appearing usually each year, and each spring as the buds begin to grow, radial growth begins and spreads downwards from the buds, but the lower and more shaded the branch, the slower the radial growth activity spreads down it. As a result, the cambium is growing actively on the main trunk, around the bases of the lower branches, before growth has begun on the branch bases themselves. The old wood of the branch is thus gripped in the new wood of the trunk which forms around it but is not in actual union with it. Only later, as the cambium on the branch also begins to grow, do branch and main axis join in forming one common sheet of wood. In a thin softwood plank, therefore, the wood of the branch may lie loose in the wood of the trunk and, if the wood of the main stem rots away, the tapering ends of the whorl of branches may often be seen projecting inwards into the hollow trunk (Fig. 4).

In the hardwood, branches do not arise in so regular a manner, or so many at one level, but when growth begins, the branch base and the main axis at the same level commence growth at almost the same time. Main stems and branch therefore join in forming a common layer of wood from the outset, and thus the knot, even in a thin plank, will be firm. This continuity of wood from the branch to the main axis is clearly shown in Fig. 4.

In both poplar and oak in Great Britain, branches that do not make good growth tend to be cut off before they wither, by a natural process of abscission (see Fig. 5). This happens especially with flowering branches of the Canadian black poplar, and each summer the ground beneath trees that have commenced to flower is carpeted with branches with smooth expanded bases which have fallen from the trees, while saucer-shaped scars are left on the branches from which they have fallen.

In the softwood, the living cells of the cambium are like very long, thin threads. Each thread grows in size and then cuts itself lengthwise into two equally thin threads, of which the inner one will in time become a new wood element, as seen in Fig. 2. In the process it will absorb much water, its wall will thicken and lignify, its living contents will disappear, and it will thus become a fibre or tracheid. All these fibres are of much the same size, a few millimetres long, and they all expand about the same amount during development, more in the early part of the season, when they form the thin-walled spring wood, less later on when they form the summer wood, so that each year's ring of wood is thus recognisable as an annual ring. As all the developing tracheids, cut off from the cambium at the same time, do the same thing, to the same extent, in about the same period of time, the wood is very regular and composed entirely of similar fibres. When these developing tissues were scraped off the old wood in June, a fine spray shot into the air to a height of more than a foot, so that the liquid in these minute developing tracheids must have been held under great pressure. It is this pressure, squeezing the soft cambium cells out against the inside of the bark, which probably

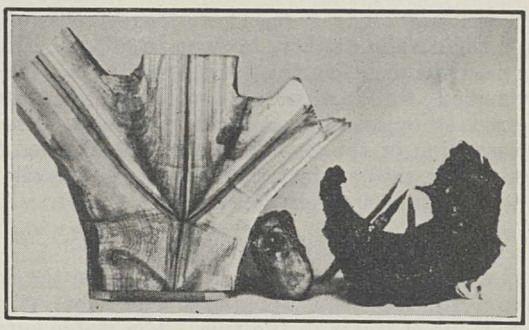

Fig. 4.—On left, a branch union in a hardwood (Large-leaf maple), showing clearly the continuity of wood from branch to main axis. In the centre (Grand fir) and on the right (Douglas fir) are cross sections of softwoods, in which the inner wood of the main stem has rotted away, leaving the tapering ends of the wood of branches projecting into the hollow cavity. The branch of the Grand fir, in the centre, was growing horizontally and has formed more wood on the lower side. (Photograph by Mr. Pemberton, British Columbia.)

accounts for their curious shape. The more vigorous the growth of the tree, the longer these thin flattened threads of cambium cells become.

In the hardwood, on the other hand, the cambium cells are much shorter, smaller cells, and cut off cells like themselves towards the wood, which later may take in water and expand. But these short cells have transverse walls at the top and the bottom, which collapse under the strain, so that the contents of the cells coalesce. This happens to certain vertical series of cells over long distances

in a very short time, so that a long row of such tiny cells expand very considerably in width and coalesce end to end to form a vessel which may be many feet in length and more than a tenth of a millimetre in diameter, as shown in Fig. 3. The formation of this vessel, like cambial activity, begins beneath the bud and spreads thence very rapidly downwards. It follows that, at lower levels, the cell which lies just in the line of such a vessel is expanding with water before its neighbours which were formed at the same time, and its expansion takes place at their expense. The vessel segment expands relatively greatly, whilst the other cells are squeezed and elongated. These longer cells, when later their walls thicken, become the fibres. Thus the hardwood, in contrast to the softwood, has a diversified wood structure, with vessels interspersed amongst elongated narrow fibres, whilst the swelling of the vessels is not accompanied by a great pressure against the cambium, the cells of which remain relatively short.

FIG. 5.—Twigs of oak, fallen whilst still living by a process of natural abscission. The swollen scars are shown clearly. About ½ natural size.

### WATER SUPPLY TO OPENING BUDS

These characteristic growth processes in the tree have a direct bearing upon such a problem as the movement of water in the tree. The water enters at the roots, and great forces are needed to carry it to the tops of trees which may be more than 300 feet high. It moves in the wood, in the tracheids of the softwood or the vessels of the hardwood, and it is usually assumed to-day that it is driven upwards by forces in the root and pulled by forces at work in the leaves from which water is evaporating. But we have seen that if a bud does not grow, both the bud and the twig beneath it lose water, so that the growth of the bud seems to attract water into it. Water is necessary for the growth of the bud, and an old experiment seems to throw light upon the entry of water into the bud in spring. If a cut branch is warmed in spring, water can be seen to well from the wood at both cut ends. In the uncut branch on the tree, the same movement of water will take place as the temperature rises, but now, from the way the wood has been formed, all this water will find its way into the buds, where the ends of the most recently formed wood elements are to be found. Then the bud begins to grow, and growth spreads downwards through the cambium beneath the bud.

It can be shown that both these growth processes attract water out of the old wood by osmotic forces developed in these growing tissues. Water movement in wood can be shown to take place under the operation of such forces, and the conditions to develop such forces can be demonstrated in the developing tissues. When new wood develops beneath an expanding bud, down over the surface of the old wood, water is moved from the old wood, which thus acts as a reservoir, into a new system of pipes the terminus of which is to be found in the elongating shoot with its new leaves. It is evident that this is the way in which the new shoot obtains its water, and that this is the explanation why a branch that does not grow loses its water to the growing parts of the tree. This gives us quite a new picture of water movement in the tree, which is no longer seen as a movement along one set of pipes, either pushed from below or pulled from above in direct continuity with the new shoots.

### WATER SUPPLY TO THE EXPANDED FOLIAGE

During the winter, when water still enters the roots and the shoot system is not growing, the supply of water in the old wood is increased; but immediately growth begins in spring, water is drawn from the old wood into the new tissues, and a simple type of experiment shows that it is withdrawn more quickly than it is replaced. When the wood is cut open under a coloured liquid such as Indian ink, no ink enters the newly developing vessels, which are obviously full of liquid, but it rushes into some of the old wood lying just beneath these new tissues, thus showing that their contents are in a condition of tension. In early summer, when the leaves are expanded, the ink will also enter the first formed of the new wood elements, the contents of which must also now be under tension. This experiment is most striking if carried out in June with the ash, when the long vessels lie just below the surface of the cambium and are visible to the naked eye. When they are cut open under Indian ink, the ink shoots both upwards and downwards at a rate which often exceeds 20 ft. a minute, and thus travels to a distance of many feet from the place of injection. The ink will not pass the cross walls which close the vessels at intervals, but lead nitrate will do so, and can be shown to travel in a few minutes down into the roots and up into the leafy shoots. The experiment has a very practical side, because it shows how soluble poisons may be successfully used to kill a tree. This is sometimes a real need, as in tropical Africa at present, where control of the movement of the tsetse fly is being attempted by completely clearing belts of country of vegetation.

It is usually assumed to-day that when the contents of the wood are in a tensile condition, the wood contains liquid sap at relatively high ten-

sions. This view is difficult to reconcile with the rapid entry of the injecting fluids, and the result of further injection experiments is to suggest that many wood elements in tension contain water vapour. Such elements, when water is available, will readily fill with water again. These observations do not solve the problem of the ascent of sap in tall trees, but they do suggest it is ripe for reconsideration. They also remind us that the buds and branches at a great height always obtain their water by a machinery that is only set in motion by their own growth.

Similarly it may be pointed out that the downward movement of food in the tree—a movement that is usually associated with the bast—seems to be linked with the growth of the bast. This tissue is also formed from the cambium, its formation beginning in the leaf, whence the process spreads gradually down the branches to the trunk and the roots; and the spread of this process of growth synchronises with the time at which a gain of dry weight takes place in the lower regions of the tree. If an attempt is made to estimate the amount of transfer of substance involved in the formation of the new tissues from the cambium, this downward-progressing growth process evidently largely accounts for the movement of substance that takes place. It is clearly impossible to dissociate the problem of transport in the tree from the processes of growth.

## Measurements of Solar Radiation *

THE work of the Smithsonian Institution's Astrophysical Observatory during the decade 1920–30 is described in vol. 5 of its *Annals*, recently published after an interval of ten years since the appearance of the preceding volume. To assist the reader in forming a proper perspective view of the work, the volume is prefaced by a brief description of the long research on solar radiation undertaken by the Observatory, first under Langley, and later under Dr. C. G. Abbot. It forms an impressive account of a great investigation, of fundamental importance to meteorology, in which the Smithsonian Institution has been the pioneer and practically the sole worker. The latter is to be regretted, since it is desirable to have independent determinations of so important a quantity as the sun's radiation. There is fortunately no doubt, however, as to the substantial accuracy of the mean Smithsonian value of the ' solar constant '.

One decisive result has emerged from the work of the Observatory, as a consequence of gradual improvements both in the instruments and methods of observation, and in the understanding and reduction of the measurements. It is that the sun's radiation, as it reaches the outside of the earth's atmosphere, and after correction to the mean distance of the earth from the sun, *is* constant within very narrow limits. At earlier stages of the work the Smithsonian view was contrary to this; it was contended that the observations showed variability over a range often exceeding five per cent; the supposed variations ranged over several per cent in the course of years, and showed correlation with the sunspot period; there were also variations over short periods of a few days, which were believed to be confirmed by independent observations for more than fifty days at Bassour in Algeria and Mount Wilson in California. Important consequences for terrestrial weather and weather forecasting were inferred from these results.

In the present volume an account is given of the establishment and progress of several solar radiation observatories, located on mountain tops in desert lands, at which a daily record of the sun's radiation is attempted, both as received at ground level, and as inferred after allowing for atmospheric absorption. The conclusion is reached that " the earlier impression [of considerable solar variations] is not supported ". " We incline to think that the earlier impressions of a larger solar variability were founded on measurements too much affected by terrestrial atmospheric influences. A residuum of apparent solar variation remains, nevertheless, after making all possible improvements. Comparison of results of remote stations; correlations with other measurements independently made by other observers; and especially correlations with weather changes at remote stations, all incline us to consider present indications of solar variation as largely real " (p. 5). The average deviation of the solar constant as measured at a single station on a single day is given (p. 244) as 0·29 per cent, the probable error being 0·24 per cent, as derived by comparing the measurements of the best station (Montezuma, Chile) with those made at Table Mountain (1926–30).

These changes are very small, and in view of the great difficulties involved in correcting accurately for atmospheric absorption, a proof of real solar variability must, as is stated, be very difficult. Comparison of the variations recorded at Montezuma and Table Mountain, in cases where satisfactory daily observations occurred consecutively at both stations simultaneously over intervals of ten days or longer, is thought, on the whole, to show a great similarity in the march of the curves, though there are instances of great dissimilarity. But it is pointed out that in these intervals solar changes exceeding 1·5 per cent are rarely indicated.

My own impression, after reflecting on the observational difficulties, the possibility of accidental agreements between the changes at different stations, and the past history of the research, is that the reality of these small variations is not proved. To establish them, much better evidence is required in the form of long-continued observations at different stations, and also independent determinations by different methods at the same station. The correlations with other measurements, and especially with weather changes, which

* Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. 5 (Pub. No. 3121). By C. G. Abbot, L. B. Aldrich, and F. E. Towle. Pp. ix+295+11 plates. (Washington: Government Printing Office.)

are mentioned as accessory evidence in the above quotation, seem beside the point; indeed, they prompt doubts as to the soundness of the discussion and interpretation of the data, doubts which are strengthened by the description of the methods used for determining alleged periodicities in the small observed variations of the solar constant. This part of the text is taken substantially from Dr. Abbot's paper of 1931, entitled "Weather Dominated by Solar Changes", the main thesis of which has not carried conviction with most meteorologists. On this point, I am in agreement with Dr. Kimball, who, in the *Monthly Weather Review* (Dec. 1931, p. 479), wrote, "Is it rational to believe that these major weather changes are caused and explained by alleged short-period changes of less than 1 per cent on the intensity of solar radiation? A part, if not all, of this 1 per cent variation must be set off as caused by inevitable accidental errors, but even if the whole of it were real solar change, can we believe that if this small variation were to cease our major weather changes would disappear also?"

I would regret, however, to end this review on a critical note. The answer to doubts as to the solar variations will be afforded by observations which the Astrophysical Observatory is continuing, and by others for which it makes an earnest plea. While Dr. Abbot states that even the best present data, from Montezuma, fall just short of the accuracy that is required, he adds that there is good hope of making several improvements which should appreciably diminish the experimental error at all the stations.

Besides the main work relating to daily observations of the solar constant, the volume includes an account of the study of the distribution of radiation in the solar spectrum, particularly in the ultra-violet and infra-red regions not covered by the daily solar observations. One interesting and unlooked-for result of the Smithsonian work was the determination of the ozone content of the atmosphere above certain stations, from the yellow-green atmospheric transmission coefficients.

S. CHAPMAN.

## A Bibliography of Boyle

'BIBLIOGRAPHY' is a word which has many meanings. The merely enumerative cataloguing of books is the least; their discrete anatomies a higher; and highest of all is their comparative anatomy, working on from detailed observation through steps of induction and verification as rigidly and delightfully scientific as any man of science could desire. But the aims of those who practise in these loftier realms are not always single. On one hand, the pure bibliographer has for his aim the discovery of bygone methods in the various crafts of book-making; to him the matter in the volumes which he studies is no more than the 'copy' supplied to a compositor, and the mind of the author—except inasmuch as its vagaries may cause disturbances in proof, and produce variant issues—exists as a remote First Cause, beyond inquiry. How much of the archæology of the greatest art in civilisation has been discovered by such students is recognised only vaguely, even by some of the historians who might make use of it. The literary bibliographer, on the other hand, has a different aim; his primary interest in a series of books is in their author (or a group of authors); yet even he wins little enough sympathy from most of us, who are content with the innocent rôle of gentle reader.

It will be seen that the bibliographer is a lonely soul as a rule; and if he strays beyond the warmth of his own circle, the wind of the world blows past him chilly and comfortless. No wonder that he and his kind have hitherto purposely shunned contact with students of the impersonal arts of Nature, who outside *their* circle are supposed to be inhumanly heedless of persons and the past, and regardful only of things and the present. There have been, nevertheless, bibliographies (in the full sense) of scientific work: usually, however, according to subjects—such as Mr. James Henderson's "Bibliotheca Taqularum Mathematicarum"—or of a library, such as Ferguson's well-known work on the Young chemical collection. Of bibliographies of single scientific authors there must hitherto have been very few that would satisfy bookmen as well as men of science. However, the collector's enthusiasm of the late Sir William Osler for medical works set a vogue in this field, and so it was not surprising that William Harvey was the subject of the first true bibliography of a seventeenth century scientific worker, produced a few years ago by Mr. G. L. Keynes. Now a kindred interest has inspired Prof. J. F. Fulton, lately fellow of Magdalen College, Oxford, and now professor in the School of Medicine at Yale, to undertake a larger and very difficult task: the bibliography of Robert Boyle.*

Let it be said at once that Prof. Fulton has carried out the task with particular success, happily conjoining the functions of both types of bibliographer. He has not only used the resources of a score or so of great libraries in Great Britain and on the Continent, but he has also achieved the rare privilege of being himself the owner of at least one copy of very nearly every work, edition, issue, and variant that comes within the wide scope of his title. The unrestricted opportunities for close examination and repeated reading which this has given him show, by their results in this volume, the honourable side of book-collecting; and the scientific historian (or, more probably, the group of them) who may some day try to set before us Boyle's contributions to knowledge, will be deeply in Prof. Fulton's debt.

In Section A are described forty-two distinct and self-contained works by Boyle, first printed between

* *Proceedings and Papers of the Oxford Bibliographical Society*, vol. 3, pt. 1, pp. 1-172. "A Bibliography of the Honourable Robert Boyle, Fellow of the Royal Society", by J. F. Fulton. (Oxford: University Press.) 10*s*.

1659 and 1695, and afterwards in editions and issues described to the number of about two hundred. This constitutes the most important part of the bibliography. In Section B are cited forty contributions by Boyle to other works, including thirty-five papers printed by the secretary of the Royal Society in the *Philosophical Transactions*. A third section shows the editions of Boyle's collected works, including the separate theological collections; there follow ten examples of book-dedications to him, contemporary and later; ten elegies and funeral sermons; and notices of about a hundred and seventy biographies and commentaries on Boyle. An appendix contains a list of the Boyle's Lecture sermons and their preachers from 1692 to 1929, and a list of the Robert Boyle lectures which have been given at Oxford for the last forty years. The frontispiece shows the attractive bust of Boyle by Rysbrack, discovered lately at Kensington Palace by Mrs. Esdaile; and there are twenty-two facsimile reproductions of title-pages and other matter. Prof. Fulton's preface is pleasant and useful, and there is a full index.

Each separate work is introduced by a short account of its bearing upon Boyle's life and upon the parts of science which it touches together with notes of general bibliographical interest. For each volume described, there are given the full title, with indications of the types used; the collation; any sub-title; notes of relationship to other issues; any special points; and a list of places where copies exist. As to the thoroughness of the book-anatomy, the reviewer can only say that he had a few small discoveries in this field which he thought were his own—but they are all here, and many more, and his chagrin as a censor is replaced by pleasure as a pupil. Prof. Fulton's assessments of Boyle's works do not profess to be more than finger-posts, and ultimately the hoped-for scientific historian of Boyle might here and there dissent from a judgment. But, subject to this merely occasional reflection, Prof. Fulton's prefaces really add to the worth and interest of the book.

The Oxford Bibliographical Society is to be congratulated on having produced as part of its *Proceedings* a handsome bibliography which is not only new in theme and long-wanted, but also as nearly final and complete as even, perhaps, its author could desire. To his modest terminal quotation from one of Boyle's prefaces, disclaiming the world's applause, one may be allowed to reply with one from another author; Dr. Fulton's is a work "In which, though to the blind and common crowde (to whom all thats unusuall is a paradox) there may perhapps appeare what they'll dare call extravagant, and to the midle-cyzed gymnastickes what they'll conceive ill grownded though ingenious guesses, yet surely will the more solide reflections of all knowing men begette a liking of its acquaintance". Irvine Masson.

## Amalgamation of the Physical and Optical Societies

After full consideration of the scientific, legal, financial, and political questions involved, a scheme for the amalgamation of the Physical Society of London and the Optical Society has been drawn up and unanimously recommended by a Committee representative of the two Societies. The process is now complete, and a new society, the Physical Society, has come into existence.

In pressing forward the scheme to completion, the Councils of these Societies were gratified to find that they had the support of an overwhelming majority of the members of both Societies, who fully realised that, despite the grave nature of the change involved, the advantages attendant thereon completely justified the action of the Councils.

It must be understood that the scheme is, as it states, an amalgamation—a fusion of the Societies concerned. The preservation of the name of a society is a matter which has, at best, a sentimental value; the conservation and widening of the advantages of membership is the material concern. In making a balanced estimate of the advantages accruing from such a fusion, it must be remembered that the circumstances in which the Optical Society was founded are scarcely germane to the present situation. However specialised its aims may have been in the earliest years of its existence, the Optical Society, as a glance at its *Transactions* will show, has developed into a general scientific body with an outlook scarcely to be distinguished from that of the Physical Society of London.

Thirty or forty years ago, in the homely days of the Victorian era, there was room, and need, for small semi-private societies, the members of which might meet and discuss in a familiar and intimate way problems of fundamental interest in their science and profession. Matters are changed nowadays. Physical science is playing a part in the fashioning of national character and the fostering of national well-being which was undreamt of a generation ago: scientific bodies are in far closer touch with the organised activities of the community than they have ever been in the past, and unnecessary divisions and separations are to be deprecated, inasmuch as they inevitably weaken the weight of any appeal which may be made by the societies in the name of physical science. There is no question that the prestige and authority of the Society which has risen from the union of the two Societies will far exceed that of the individual Societies considered as separate units.

The amazing growth of physical science during the past generation has inevitably produced much specialism. So far from taking all knowledge for his province, the scientific man of to-day is fortunate if he can cultivate with a measure of success some one corner of one of the sciences. Nevertheless, the repercussions of physical science in general on that single division are so numerous and so important that the neglect of their study unduly hampers the serious student. It has been an important part of the business of the Physical Society of London to make possible a critical study of these repercussions; the lectures and discussions which

have been held, and the reports which have been published under its auspices, the issue of *Science Abstracts*, the fortnightly meetings in London which resulted in the reading and annual publication of some fifty papers concerned with all branches of physical science, the annual provincial meeting—all these activities have helped to provide a background for the specialist worker in physics such as could be obtained by membership of no other British society. And, as is shown by their membership of the Physical Society of London, many fellows of the Optical Society have not been slow to recognise these advantages.

In some quarters a fear has been expressed that the fusion of the two Societies will leave workers in applied optics without a forum in which to express their views. Nothing could be farther from the truth. Optical science is no longer confined to a narrow sphere of influence but has become the handmaid of all sciences, and optical instruments are now tools of industry. The amalgamation now completed is a visible sign of the union, to their mutual benefit, of the most representative body of producers of optical methods and instruments with the body which represents the largest and most important group of users of such methods and instruments. Under the auspices of the new Physical Society, the Guthrie lecture and the Thomas Young oration will be delivered as heretofore; papers on optical subjects have been a prominent feature in the *Proceedings of the Physical Society of London*, and their number will be materially increased under the new regime; arrangements for special lectures on topics of optical interest have been made, and the session now opening will be inaugurated by a lecture by Dr. J. W. French on "The Manufacture of Optical Glass"; and the probability of an increased output of papers is provided for by an increase of one part per annum in the number of published parts of the *Proceedings*.

The Councils of the Societies have no regrets in carrying out this amalgamation. They believe that it is, in brief, a plain commonsense measure fully in the spirit of the times and long overdue, and that its adoption will forward the interests of physical science and assist materially in the development of the science of optics.

## Obituary

### MR. P. M. C. KERMODE

MR. PHILIP MOORE CALLOW KERMODE, for many years the foremost authority on the antiquities of the Isle of Man, died on Sept. 5, at the age of seventy-seven years. The son of the Rev. W. Kermode of Ramsey, he was educated at King William's School, and was called to the Manx Bar in 1878. In the following year he founded the Isle of Man Natural History and Antiquarian Society, with the work of which he was closely identified for the remainder of his life.

Every aspect of Manx archæology and tradition held Mr. Kermode's interest, as was shown in the many contributions made by him to *Yn Lioar Manninagh*, the publication of the Antiquarian Society, of which he was editor. His authority was frequently invoked by the late Sir John Rhys, when dealing with Manx tradition and folklore; but his outstanding contribution to Manx archæology lies in his studies of the Celtic and Norse monuments of the island, and their inscriptions in runic and ogham, of which the results were embodied in "Manx Crosses" (1907), a standard authority, in which breadth of treatment and range of knowledge transcend local interest.

Among Mr. Kermode's more recent discoveries was that of an interesting Norse ship-burial, described last year, which revealed a ship of somewhat unusual type. In 1922, Mr. Kermode was appointed curator of the Manx Museum at Douglas, and in 1929 he received the honorary degree of M.A. from the University of Liverpool.

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WE regret to announce the following deaths:

Mr. H. C. Chadwick, formerly curator of the Marine Biological Station, Port Erin, and afterwards research zoologist at the Station, and honorary lecturer in marine biology at the University of Liverpool, on Sept. 16, aged seventy-five years.

Dr. F. H. Hatch, O.B.E., technical adviser to the Mines Department, past-president of the Institution of Mining and Metallurgy, and author of several well-known textbooks on metalliferous mining, on Sept. 22, aged sixty-eight years.

## News and Views

### Nevil Maskelyne, 1732–1811

ON Oct. 6 occurs the bicentenary of the birth of Nevil Maskelyne—the worthy successor of Flamsteed, Halley, and Bradley—who for forty-six years held the office of Astronomer Royal and will always be remembered as the founder of the "Nautical Almanac". A man of mild and genial temper, Maskelyne was admirably fitted for the post he occupied so long, and at Greenwich steadily pursued the aims for which the Observatory was founded. Ever ready to acknowledge the work of others and to further the interests of science, he gained the esteem of all who knew him, and when, after his laborious experiments on the slopes of Schiehallion, Perthshire, made to determine the density of the earth, he was awarded the Copley Medal of the Royal Society, Sir John Pringle in addressing him said that the Council presented him with the medal not only as a token of their acknowledgment of his work but as a "sincere pledge of their affection".

MASKELYNE was born in London on Oct. 6, 1732, being the son of Edmund Maskelyne of Purton, Wiltshire. At the age of nine years he was sent to Westminster School, and it is said that, like Lalande and Messier, he was attracted to the study of astronomy by the solar eclipse of 1748. From Westminster School he proceeded to Cambridge, entering first Catherine Hall and then Trinity College, graduating as seventh wrangler in 1754. The following year he took holy orders and was appointed to a curacy at Barnet. He next took the degree of M.A., was made a fellow of Trinity, and in 1758 became a fellow of the Royal Society, his first paper to the Society being written in 1760. Already known to Bradley, in 1761 Maskelyne was sent to St. Helena to observe the transit of Venus in order to determine the parallax of the sun, and two years later sailed as chaplain of the *Princess Louisa* on a voyage to Barbadoes, during which he tested the accuracy of Harrison's chronometer. The death of Bliss in 1765 leaving the office of Astronomer Royal vacant, Maskelyne was appointed to it. He had already in 1763 published the "British Mariner's Guide", and he was now able to prevail upon the Government to issue that eminently useful work the "Nautical Almanac". The almanac for 1767 was published in 1766, and for the succeeding forty-five years subsequent editions were superintended by Maskelyne. In connexion with his constant efforts to improve navigation, he edited the important lunar tables of the German astronomer Tobias Mayer (1723–1762); and obtained for Mayer's widow a grant of £3000, and for Euler, whose lunar theory he used, a grant of £300. Though in early life Maskelyne became a clergyman and afterwards received the degree of D.D., and was given the livings of Shrawardine, Shropshire, and North Runcton, Norfolk, most of his time was spent at Greenwich Observatory, and it was there he died on Feb. 9, 1811.

### International Congress of the History of Medicine

THE ninth International Congress of the History of Medicine was held at Bucharest on Sept. 10-18, under the presidency of Dr. Victor Gomoiu, with King Carol II., who opened the Congress in state, as president of honour. Two principal subjects were chosen for discussion, namely, the evolution of medicine in the Balkan States, on which papers were read by representatives from Albania, Bulgaria, Czechoslovakia, Greece, Rumania, and Turkey, and the defence of Europe against plague, to which subject the chief contributions were made by Prof. Ricardo Jorge, director of public health at Lisbon; Prof. J. Guiart of Lyons, Prof. P. Capparoni of Rome, Prof. D. Giordano of Venice, Prof. G. Sticker of Würzburg, and Prof. L. Zembruski of Warsaw.

IN addition, a number of miscellaneous papers were presented, including the history of medicine and scientific criticism by Prof. A. Castiglioni of Padua, the development of operative gynæcology by Dr. I. Fischer of Vienna, the history of spectacles by Prof. W. Reis of Lemburg, Polydore Vergil by Prof. J. F. Fulton of Yale University, and Chaucer and medieval medicine by Dr. J. D. Rolleston, delegate of the British Government and the Royal Society of Medicine, who, like other national delegates, was elected honorary member of the Royal Rumanian Society of the History of Medicine and awarded the Rumanian Order of Cultural Merit (Class II.).

DURING the Congress visits were paid to the Faculty of Medicine, Prof. J. Cantacuzène's institute of serums and vaccines, Prof. M. Minovic's medico-legal institute, and various hospitals and museums, as well as to places of general interest. The last three days were spent in a motor tour through the country in the neighbourhood of Bucharest, with visits to sanatoria, the hospital at Sinaia, and the petroleum factory at Campina. A section of the Congress of the History of Sciences to be held next year at Warsaw will be devoted to the history of medicine, so that the next Congress of the International Society of the History of Medicine will not be held until 1935, when the meeting-place will probably be Madrid.

### Aeroplane Height Record

ON Sept. 16, Mr. C. F. Uwins, chief test pilot of the Bristol Aeroplane Company, Ltd., attained a height of 43,976 ft. (about $8\frac{1}{3}$ miles) in a Vickers Vespa biplane, and on Sept. 23 this height was officially confirmed as the absolute height record. The engine used was a Bristol Pegasus nine-cylinder air-cooled radial, which is now in common use in Service machines. The engine develops 900 h.p., and for the purpose of the attempt on the height record was fitted with a larger supercharger than is fitted normally. Mr. Uwins felt very little personal inconvenience at the great height achieved. He wore electrically warmed clothing and also had an oxygen supply apparatus. The previous absolute height record was that set up by Lieut. Apollo Soucek of the United States Navy, who reached a height of 43,181 ft. on June 4, 1930.

### Roman Road and Bridge, Rochdale

THE repair of the bridge carrying the Roman road over the stream at Black Castle Clough, Blackstone Edge, having been completed (see NATURE of Sept. 3, p. 340), the bridge was declared open by Sir Alfred Law on Aug. 20, when members of the Rochdale Literary and Scientific Society and a deputation of Halifax antiquarians were present. Some interesting particulars relating to the Roman road and the bridge were given by Mr. W. H. Crump of Leeds. It would appear that the Roman road, which served the traffic between Yorkshire, Rochdale, and Cheshire, fell into disuse in the year 1740 and had not been repaired since that date. Other old bridges in the neighbourhood are a packhorse bridge which was about ten feet wide, and another, eight feet wide, which carried the road to Oldham. The width of the bridge, now restored to its original seventeen feet, was far greater than anything required to carry the traffic of the district at any time since Roman days. The course of the packhorse road to Lydgate can still be seen on the adjacent hillside. In places it crosses the Roman road, in others it is some distance away. Its relation to the bridge can be seen from the fact that part of the pack-

horse road was destroyed in quarrying the material from which the bridge was built. The bridge now bears the inscription, "Restored 1932, J. H. Price", to commemorate the fact that the restoration was carried out on the initiative and under the supervision of Mr. Price. As previously mentioned, the workmen were volunteers from the unemployed, and material was given or lent by local contractors.

### Undeciphered Scripts

ACCORDING to a letter from Sir Denison Ross in the *Times* of Sept. 21, M. Guillaume Hevesy, a Hungarian resident in Paris, has discovered that a number of the signs of the prehistoric Indian script on seals from Mohenjo-daro also appear in the script of the Easter Island inscribed wooden tablets, while some of the Easter Island signs, not present on the Indian seals, are to be found in the proto-Elamic of Susa. It would now be interesting to hear whether there is any coincidence in the interpretation of the prehistoric Indian signs suggested by Sir Flinders Petrie (see NATURE, Sept. 17, p. 429) and those suggested for the Easter Island script in the Report of the Committee of the Royal Anthropological Institute of which Mr. Sidney Ray was chairman. The suggestion of a connexion between the two scripts is not the only attempt to find an affinity between Easter Island and this part of Asia. M. J. Hackin, of the Musée Guimet, has recently directed attention to the resemblance which has been noted between the wooden statues, probably ancestral, which were objects of reverence among the Kafirs of Afghanistan before they were overwhelmed by Islam, of which examples are now preserved in the Kabul Museum, and the well-known statues of Easter Island. The resemblances certainly are strong, although it might be argued that they do not go beyond what may be due to the limitations of an undeveloped technique. It must also be admitted that when the material which it is sought to bring into relation is so widely separated in date as in these instances, the comparison, in default of intervening links, carries more interest than conviction.

### The Development and Use of Talking Films

EVERY improved facility of communication has profoundly affected civilisation. The telegraph and the telephone and the widening of their scope by radio waves have benefited mankind. In the *Journal of the Franklin Institute* for August, H. M. Wilcox points out that the latest outcome of science, the talking film, has many useful applications for social and educational purposes which are not yet fully recognised. For example, a test was recently conducted at the Teachers College, Columbia University, to find the relative values of private study and seeing and hearing a talking film. Certain highly technical aspects of the training of teachers were presented by a talking film which lasted twenty minutes. Half of a group of students attended this, whilst the other half were given the monograph from which the film was constructed to study for half a day, but did not see the picture. A subsequent examination showed that the former group attained considerably higher marks than the latter. The author also lays stress on the fact that the talking film can democratise education in much the same way as it has democratised the dramatic stage. The great teacher can be taken to students in the most remote districts, and material presented to them which hitherto has been available only for the chosen few.

MR. WILCOX also shows how highly technical are the problems of recording and reproducing sounds. Sound is judged by its pitch, volume, and quality (timbre). The pitch is measured by the frequency, the range being 16-16,000 cycles per second, and is frequently called the sound spectrum. The volume or loudness is measured in terms of energy intensity or pressure. Since the ear hears logarithmically, this is expressed in terms of logarithmic units called decibels. One decibel is approximately the smallest change in volume which the ear can detect. The quality depends on the presence of overtones, the frequency of which is an integral multiple of the fundamental tone. Male speech has a range of 100-250 cycles, and female speech, 200-500 cycles. Practically none of the characteristics of speech by which we recognise one articulate sound from another is particularly influenced by varying the fundamental. Early experience with talking films proved that, unlike silent films, the acoustic properties of the theatre itself had to be taken into account. This showed that both qualitative and quantitative acoustic measurements had to be made. This has led to the development of special instruments, the frequency analyser, the level analyser, the reverberation meter, and the noise meter, which are now successfully used for analysing the acoustic conditions in theatres, and in many other places as well. The success of the recent piano recital by Paderewski before an audience of 16,000 in Madison Square Garden without the use of any sound amplifying device shows what can be done by proper acoustic treatment.

### The Swiss Broadcast Network

PRACTICAL experience seems to prove that radio transmission can only be utilised to its greatest advantage when wire connexions are used in part of the circuit. In the early days radio was a competitor with wire transmission, but now it co-operates with it, the co-operation being to their mutual advantage. The transmitting stations in a broadcast system are situated outside the cities where the studios are situated, and are connected to them by wires. In *Electrical Communication* for July, A. Muri, chief engineer of the postal administration at Bern, gives an interesting account of the Swiss broadcast network. For broadcasting purposes, Switzerland is divided into three zones. For French-speaking Switzerland, the main transmitter is at Sottens and is fed by the studios at Lausanne and Geneva. For German-speaking Switzerland, the main transmitter is at Beromünster and there are two relay transmitters at Bern and Basel. All three transmitters broadcast the same programme, and are fed from the studios at Zurich, Bern, and Basel as required. The main transmitter for Italian-speaking Switzerland is still under construction at Monte Ceneri. When completed it will be

served by the studio at Lugano. In order to meet the requirements for music transmission, circuits having a cut-off frequency of 10,000 are provided. This enables a sound spectrum of 35-7500 cycles per second to be obtained without distortion. In addition, there exist lightly loaded circuits having a cut-off frequency of 6800 cycles, giving a range of 150-5000 cycles for broadcast speech transmission. At present 87 per cent of all the toll circuits are in underground cable.

### Broadcasting and Television in France

*La Nature* for Sept. 1 is devoted exclusively to an inquiry on television and broadcasting. The views of several eminent technicians both in France and other countries are given. Manfred von Ardenne takes an optimistic view of the progress of television in Germany and looks forward to a great increase in the art before next winter. Maps are given showing a national scheme for radio diffusion in France and comparing it with the present system. A description is given of the new short-wave transmitter in Berlin, the largest in the world. Power of 15 kilowatts is emitted by waves seven metres long. It will help in the solution of certain problems in television and in producing broadcasting free from disturbance. The legal aspects of the problems which arise when a 'listener' is disturbed by induction from apparatus working in the neighbourhood are considered at length. Several law cases are quoted which show that the rights of listeners are recognised in France, and that those who use apparatus which interferes with the working of a private user's set are liable to substantial fines. The disturbances may be due to an electric motor driving a gramophone, neon tube lighting, the working of a cinema, the electric bell system on the ground floor, and public electric supply systems. In certain cases the use of devices to prevent interference is enforced. In conclusion, the influence of American improvements on the design of French receiving sets is discussed.

### An Early Diffraction Grating

THE June issue of the *Journal of the Franklin Institute* contains two interesting letters from the second volume of the *Transactions of the American Philosophical Society* (1786), from which it would appear that a transmission grating had been used to produce spectra prior to the work of Fraunhofer (1820). The first, which is addressed to David Rittenhouse from F. Hopkinson, of Philadelphia, has a description of the appearance presented when a street lamp is viewed through a silk handkerchief, and contains a request for an explanation of the pattern formed. The second, dated eleven months later, is Rittenhouse's reply. From its contents, and the lapse of time from the first letter, it appears that he had given considerable thought to the matter. Starting with the observation that the experiment is more curious than one would at first imagine, Rittenhouse then describes the grating he made to perform it with more accuracy. He constructed a square of parallel hairs, about half an inch each way, laid into the threads of two fine screws, with a pitch of 106 to the inch, which he had cut from brass wire. With this he observed a small opening in the window shutter in a dark room, at first with the unaided eye, and later with a prismatic telescope and micrometer, to measure the angular separation in units of the pattern. Six orders of diffraction were observed on either side of the zero, and measured up, and he noted that the dispersion of colours was in the opposite sense to that obtained with a prism, which he considered parallel to Newton's observations on the colours of fringes at the edges of shadows. Rittenhouse was unable to carry out the calculation of wave-lengths from his observations, as Fresnel's theory of diffraction did not appear until 1815, but his data lead to quite good results: 6200 A. for the red, and 4600 A. for the blue. He does not appear to have followed the work up further, so far as this correspondence goes. Fraunhofer's work was of course the more complete, but this experiment is interesting as coming in the gap between the time of Newton and that of the great optical researches of the early nineteenth century.

### Hydro-electric Power on the Dnieper

A REPORT from Washington states that "Dneprostroy" was dedicated on Aug. 25. This hydro-electric power project on the Dnieper River, with a capacity of 756,000 h.p., is the largest in the world. The power will be available for metallurgical and chemical industries and to irrigate the rich but droughty steppes. Ships from the Black Sea will now be able to penetrate hundreds of miles farther inland. The cost is approximately 110,000,000 dollars, and the dam, the largest ever constructed, was constructed ahead of the schedule. The dam is 3350 feet long and 140 feet high to the crest of the spillway, above which water may rise 30 feet during floods. The structure impounds a flow varying from 6300 to 835,000 cu. ft. a second at times of large freshets. Six of the nine power units are now being installed. The turbines have a rated capacity of 84,000 h.p., and 100,000 h.p. under a maximum head of water. The maximum or high-water capacity is 900,000 h.p., but owing to irregular flow, only three of the units can be operated during the entire year.

### Agriculture in the East of England

THE report on an "Economic Survey of Agriculture in the Eastern Counties of England" issued by the Department of Agriculture, University of Cambridge, and published by Messrs. Heffer and Sons, Cambridge, price 2*s.* 9*d.* post paid, presents an analysis of the financial results for 1931 of nearly a thousand farms in the province. During the year farmers in this area experienced heavy losses. The general price level of agricultural produce averaged 18 per cent below that necessary to provide occupiers with a reasonable return for their own labour and capital investment. The majority of those farmers who were fortunate enough to secure a profit enjoyed special marketing facilities, retailed milk or concentrated on the production of livestock and livestock products, or both. As the eastern counties are generally described as a grain-growing area, it is rather surprising to find that while sales of cereals amounted to less than 14 per cent of the gross income, sales of livestock and their products

represented nearly 70 per cent. The very low prices obtainable for the 1931 cereal crops influence these proportions, but even taking this into consideration, cereals can be described as an important cash product on the larger farms only. The success of the small farmer, and these form the majority, is more dependent on the price of livestock and feeding stuffs than on those of cereals. Interesting comparisons are made of the organisation of the agriculture of the principal farming localities of the province: for example, central Norfolk light loams, the Norfolk 'breck', central Suffolk heavy soils, south Essex London clays, south Cambridgeshire gravels, etc. The most depressed areas are the boulder clays of Essex and Suffolk, and the clays in west Cambridgeshire and Huntingdonshire. The report deals further with main factors influencing profits and with many other subjects of interest to administrators and to farmers.

### Electricity and the Farmer

A PAPER read by F. E. Rowland at the Royal Agricultural Show, Southampton, on July 7 and printed by the B.E.D.A. (British Electrical Development Association, Inc.) of 15 Savoy Street, W.C.2, gives helpful hints to farmers as to the best way to apply electricity to their farms. The price of the unit is taken as 2*d*., and when it can be obtained at this price a good case is made out for using electric power. In many cases when space is limited, as in stackyards, electric drive has many advantages. 18 sheep can be sheared per unit expended, or 45 horses groomed, or 12 horses clipped. Motors can be rolled from one part of a farm to another inside wooden drums. Excellent and economical methods are given of lighting farm buildings and roads. Electrically driven pumps provide automatically a plentiful supply of water for all purposes. The use of electric milkers which require a $\frac{1}{2}$-h.p. motor is becoming widespread in England. In New Zealand 15,000 are in use. By the expenditure of one electric unit, 22 cows can be milked, 120 lb. of butter churned, or 1000 bottles washed. Accurate data are given as to the effect of poultry lighting in stimulating egg production.

### A New Journal of Animal Ecology

IT is gratifying to find that zoological analysis, having for long been largely confined to the laboratory, is being pushed with vigour into the open country, the obvious place for testing and resolving some of the big problems of animal life. So insistent has been the demand for space to publish the results of observations upon animal populations, their distribution, fluctuations in numbers, migrations and the like, and to concentrate observations of the kind for the convenience of field-workers and zoologists in general, that the British Ecological Society has decided to issue, twice a year, a *Journal of Animal Ecology*, under the editorship of Charles Elton, assisted by A. D. Middleton. The first number, which appeared in May from the Cambridge University Press, is an attractive volume, in appearance as well as in matter. It contains many-sided contributions, from studies of the fluctuations of insect populations in wheat and of bird numbers on an Oxfordshire farm, to a rookery census, an analysis of the ranging habits of wood-ants, and an account of the biology of the fruit-bats of Australia. There are many illustrations, and a useful reference list contains summaries of papers dealing with animal ecology. Members of the British Ecological Society (Secretary, Dr. H. Godwin, Botany School, Cambridge) obtain the *Journal* for their subscription of 25*s*., to non-members the price is 30*s*. The magazine promises to make a niche of its own in British zoological literature, and the interest of its outlook ought to draw many supporters. We understand that so far as suitable material is concerned its success is assured.

### *Acta Phaenologica*

THE new bi-monthly international journal *Acta Phaenologica* aims at concentrating the hitherto scattered studies in phenology and offering an opportunity to "set forth various tendencies, stages of development, points of view of different centres of phenological experiment, and by giving a chance to consult on aims and methods, to achieve useful and active collaboration". The journal is issued under the editorship of the board of the Phenological Association of the Netherlands, and in the first part (Sept. 1931: Publ. Martinus Nijhoff, The Hague) the Secretary, Dr. H. Bos, writes on the scope and prospects of phenology. In the same number there are articles by J. Edmund Clarke on "The Cold Spring of 1929 in the British Isles" and S. Illichevsky on "The Results of the Phenological Observations at Poltava (U.S.S.R.)". The second part includes contributions from Prof. Ihne on "The Beginning of the Phenological Spring in Central Europe during the Ten Years' Period, 1921–1930", Prof. Poggenpohl on "Phenological Observations, 1886–1907", and Dr. H. Bos on "The Dropping of Small Fruits after Blooming". Contributions are accepted in English, French, or German, and each is accompanied by a translation of its title and a short summary of the contents in the two other languages.

### Habits of the Woodpecker

ALTHOUGH a tame woodpecker is mentioned by Aristotle, the birds of this family have never been favourites with aviarists, and even the London Zoological Society, after having exhibited at different times no less than seventeen species, had been without a specimen for years until a family of the British greater spotted species arrived recently, and were accommodated with a special cage in the Bird House. Here they attract attention by their extreme activity, which is very characteristic of woodpeckers; they contrast in this respect with their nearest allies the barbets, of which several species are on view, much as tits do with finches. It is of interest to note, however, that the pair-toed feet, often supposed to be an adaptation for climbing, are to be found in the more primitive group of barbets, which do not climb, and that these peck wood when excavating a nest-hole, although their beaks are not specialised into the chisel-type of the woodpeckers' bills, and they do not

dig for food. Thus the woodpecking habit would seem to be older than the woodpecker; and that the pair-toed foot is not specially adapted for climbing is also shown in the fact that in several genera of woodpeckers the hallux or true hind-toe is absent or aborted, so that the foot ceases to be pair-toed.

### Detecting Insect Pest Attacks

MR. A. M. MASSEE, of the East Malling Research Station, is to be congratulated on his simple methods for early detection of epidemics of certain insect pests of fruit trees (Ann. Rep. East Malling Research Sta., 1931, pp. 78-80). For example, attacks of caterpillar, aphis, or sucker can be detected if twigs from trees in various parts of the orchard are caused to produce growth early by placing them in water in a warm place. The growing spurs reveal the presence of pests which would not be recognisable in the ordinary way until the natural time of bud break. It is also possible to spray black currant bushes against big bud mite at the most effective moment, namely, just when the mites are migrating. A few affected branches are placed in a jar containing sand and water in the open; daily observation with a hand lens will show when the mites appear on the outsides of the buds, and so will also indicate when spraying should be performed. The idea will help materially to raise horticulture to the status of a more exact science.

### Modern Milk Production

SUCCESS in dairy farming depends on the exercise of efficiency with economy in all departments of the industry. The main factors concerned in the cost of production are the milk-producing quality of the race and herd, the care given to breeding for milk production, housing, feeding, and general management. For the guidance of dairy herdsmen, the Ministry of Agriculture has issued a pamphlet (Bulletin No. 52, price 9*d*. net) in which all these factors are considered, and in which the most up-to-date methods of milk production are set forth clearly and in well-classified arrangement. The Ministry has had the advantage of the assistance of experts who have carried out extensive investigations into the many questions connected with the business of milk production, and it goes almost without saying that the result is an attractive as well as a highly practical guide.

### A Serious Poultry Disease

THE Ministry of Agriculture and Fisheries issues a warning against the possibility of introducing the disease known as bacillary white diarrhœa into flocks by the purchase of infected chicks from hatcheries. Serious losses may be caused by such agency, the more to be regretted as a little preliminary precaution might have avoided the introduction of the disease altogether. It is conveyed to the chicks by infected hens through their eggs, so that it is of the utmost importance that the breeding stock should be free from the disease. Now, hens which are carriers of the disease may be recognised as such by the agglutination test, and eliminated from the breeding stock; so that a purchaser of eggs for hatching or day-old chicks should insist that the stock from which his supplies are obtained has been declared free of reacting birds. A number of county authorities for agricultural education now accredit poultry-breeding farms where the quality of the breeding stock reaches an approved standard, and where birds have been subjected to the agglutination test according to regulations laid down by the scheme.

### Lecture Tours at the Natural History Museum

OWING to the success achieved by the appointment of guide-lecturers at the national museums and galleries, it has been decided to inaugurate more advanced lecture tours at the British Museum (Natural History), to be conducted by members of the scientific staff of the Museum, on Mondays at 12 noon, commencing on Oct. 3. It is announced that Miss M. R. J. Edwards has been appointed official guide-lecturer at the Museum in succession to the late Mr. J. H. Leonard, who died at the end of last year (see NATURE of Jan. 2, p. 15).

### Announcements

MR. W. F. HIGGINS, principal assistant of the physics department of the National Physical Laboratory, has been appointed secretary of the Laboratory in succession to Mr. F. J. Selby, who recently retired.

MISS PENELOPE JENKIN, of Newnham College, Cambridge, has been appointed by the trustees as Ray Lankester investigator at the Marine Biological Laboratory, Plymouth, for the year 1933. Miss Jenkin will attempt to correlate the rate of photosynthesis of diatom cultures immersed at different depths in the sea, off Plymouth, with photoelectric measurements of light penetration made by Dr. W. R. G. Atkins.

A DEMONSTRATION of contraceptive technique will be given at the Clinic of the Society for Constructive Birth Control on Oct. 5, at 2.30-5 P.M., to medical practitioners and senior medical students only, who will be given an opportunity of practising various methods under tuition on women patients. Lectures and demonstrations will be conducted by Dr. Beddow Bayly and Dr. Evelyn Fisher and the midwife-in-charge. Applications for tickets (which are necessary) should be made to the Honorary Secretary of the Society, 108 Whitfield Street, W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An engineer in the Burma Marine Service—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (Oct. 15). A Lawrence research student for research in some subject related to the cause and cure of disease in man and animals—The Assistant Secretary of the Royal Society, Burlington House, London, W.1 (Oct. 24). A professor of chemical technology at the University of Bombay—The Secretary, Universities Bureau of the British Empire, 88A Gower Street, London, W.C.1 (Nov. 7). An assistant to teach general mechanical engineering at the Darlington Technical College—Chief Education Officer, Education Office, Darlington.

## 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.*]

### Selective Transmission of γ-Radiation by Lead

SEVERAL workers have recorded an apparent anomaly in the γ-ray absorption of lead. Investigations carried out in this laboratory seem to throw new light on the phenomenon.

The mode of attack consisted in the continuous comparison of the γ-ray transmission through pairs of screens, lead and bismuth, lead and thallium, lead and copper, etc., when using as the source of radiation the ageing active deposit obtained in freshly filled radon

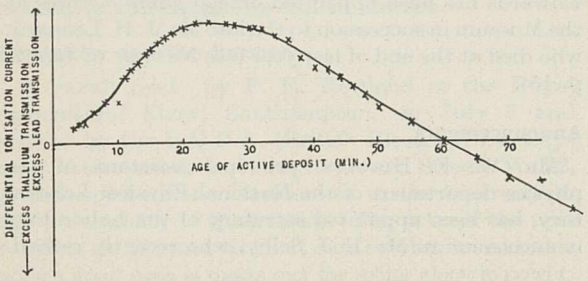


FIG. 1.—Selective γ-ray transmission from radium B through lead as compared with thallium. Source—80 m.c. radon. Screens—0·3 m.m. lead and 0·3 m.m. thallium.

containers. Comparisons carried out before the attainment of the transient equilibrium between radium *B* and *C* show that the transmission ratios Pb/Bi Pb/Tl gradually increase to a maximum and then decrease. An uncorrected set of readings obtained when using a method in which the differential ionisation currents were measured is shown in Fig. 1.

It would appear from these experiments that *a substance is selectively transparent to some at least of the radiations emitted by its radioactive isotope.* A more detailed account of the method of observation and the results obtained will be published in another place.

F. L. HOPWOOD.
T. E. BANKS.
T. A. CHALMERS.

Physics Department,
St. Bartholomew's Hospital,
Medical College, E.C.1,
Sept. 3.

### Magnetic Moment and the Chemical Bond in Alloys

FORRER,[1] Sadron,[2] and Néel[3] have recently published several articles in which they compute the elementary moments of different substances at small concentrations in nickel alloys. Their empirical results are interesting, but their theoretical conclusions cannot be brought into agreement with modern views on atomic structure.

The empirical material may be re-interpreted on the basis of the following assumptions: 1. According to Stoner,[4] pure nickel consists, at low temperatures, of 40 per cent neutral atoms with zero moment and 60 per cent singly ionised atoms with a moment equal to 1 Bohr magneton ($M_B$). 2. Every foreign atom entering the nickel lattice becomes singly ionised. 3. The number of ionised atoms in the alloy at low temperatures, with small concentrations of foreign metals, is related to the number of neutral atoms in the same way as in pure nickel. 4. Contrary to my previous view, the conduction electrons do not play any important rôle in ferromagnetism.

With these assumptions, the following values for the effective magnetic moments per atom may be calculated from Sadron's data:

$$Ni^{+}1 \quad Cu^{+}0 \quad Zn^{+}-1 \quad Al^{+}-2 \quad Sn^{+}-3 \quad (M_B).$$

The negative values of the moments of $Zn^+$, $Al^+$, and $Sn^+$ correspond precisely to the number of valence electrons left attached to the corresponding ion. This remarkable fact may be interpreted as follows: The positive 1 $M_B$ moment in nickel is produced by one 'missing' electron in the incomplete 3*d* shell, as pointed out by Stoner; while the negative moments are produced by 'superfluous' electrons of the corresponding ions. This leads to the conclusion that the secondary valences are compensated by mutual atomic linkage; so that a $Zn^+$ ion destroys one elementary magnet (equal to 1 $M_B$) in $Ni^+$, an $Al^+$ ion destroys the magnetism of two $Ni^+$ ions, and a $Sn^+$ ion of three. This interpretation enables us to understand why a $Pd^+$ ion, which possesses a missing electron, a 'hole', in the 4*d* shell, plays the rôle of a ferromagnetic in nickel, with the same moment as nickel itself. A study of the nickel-iron and nickel-cobalt alloys shows that iron inside nickel has $3M_B$, due to 3 missing electrons, and cobalt $2M_B$, due to 2 missing electrons in the 3*d* shell. The same ionic states are found from susceptibility measurements above the Curie point as from magnetic saturation values at low temperatures. This is shown in the following table:

| Metal. | Electronic State of Singly Ionised Atom. | Magnetic Moment from Saturation Value ($M_B$). | | Magnetic Moment from Susceptibility (Weiss units).[5] | |
|---|---|---|---|---|---|
| | | Calc. | Obs. | Calc. | Obs. |
| Fe | $d^7$ | 3 | 3·2 | 22–26 | 20–22 |
| Co | $d^8$ | 2 | 1·8 | 14·5–17 | 15 |
| Ni | $d^9$ | 1 | 1 | 9–11 | 8–9 |

These results seem to open up a new approach to the problems of the chemical bond in metals and of the inner structure of ferromagnetic alloys.

J. DORFMAN.

U.S.S.R., Leningrad (21),
Sosnovka 2, Phys.-Techn. Institute,
July 1932.

[1] R. Forrer, *J. Phys.*, October 1930, p. 325.
[2] C. Sadron, Dissert., Strasbourg, 1932.
[3] L. Néel, Dissert., Strasbourg, 1932.
[4] E. C. Stoner, *Proc. Leeds Phil. Soc.*, **2**, 149; 1931.
[5] From solid salts containing ions with the same number of electrons.

### Influence of Light on the Gorging of *Culex pipiens* L.

IN connexion with the account given by Dr. Tate and Miss Vincent, in a recent letter to NATURE,[1] of experiments made by them and other investigators regarding the biting habits of *Culex pipiens* in England, the following corroborative observations may possibly be of interest.

During a long series of experiments carried out by us last year, in the course of which female mosquitoes of various species were fed in *daylight* upon human blood, we found that females of *Anopheles maculipennis, claviger, plumbeus*; *Theobaldia annulata, subochrea*; and *Aedes caspius, maculatus, rusticus, detritus, punctor, geniculatus* would bite readily enough. Females of *Culex pipiens*, on the other hand, were

induced to take human blood on seven occasions only, details of these cases being given in the following table:

| Number of *C. pipiens* Females induced to bite. | Date (1931). | Time of Day. | Temp. (Cent.). | Percentage Humidity. |
|---|---|---|---|---|
| 1 | June 26 | 4.15 P.M. | 18° | — |
| 2 | July 22 | 5.0 P.M. | 19° | 80 |
| 2 | ,, 23 | 5.30 P.M. | 20° | 75 |
| 1 | Aug. 27 | 9.30 A.M. | 17° | 78 |
| 1 | ,, 28 | 6.0 P.M. | 18° | 79 |

In all our experiments, the mosquitoes (whatever their species) were fed in front of a large window facing east. The female *C. pipiens* which bit on Aug. 27 did so in bright sunshine.

It may be noted that, according to Stitt,[2] the yellow fever mosquito, *Aedes argenteus*, may take its first meal of blood in the daytime, but all its subsequent bites are made during the night. This peculiarity is certainly *not* a characteristic of any of the British species with which we have experimented.

Early in May last we collected a number of *C. pipiens* females shortly after the conclusion of hibernation. In those which had obviously fed recently we found, on dissection, the oval, nucleated blood corpuscles pertaining to birds. The adults which appeared to have fed less recently were set aside for oviposition. One of these, after ovipositing, was induced to take two (daylight) meals of human blood, separated by an interval of eleven days; it was found dead, however, two days later. Although fully gorged after the first of these meals, no further oviposition took place and no fat-body accumulated; the insect being found in an emaciated condition when dissected. The ovaries, though not exhausted, had undergone no development.

Of a number of *C. pipiens* females collected during the latter half of last month, eight were found to be gorged with avian blood.

J. F. MARSHALL.
J. STALEY.

British Mosquito Control Institute,
Hayling Island, Sept. 20.

[1] NATURE, Sept. 3, p. 366; 1932.
[2] Stitt, E. R., "Bacteriology, Blood-Work and Animal Parasitology", 1920.

### Vectors of Mediterranean Kala Azar

IT has been previously shown[1] that both *Phlebotomus perniciosus* and *P. major* give high infection rates when fed on Chinese hamsters infected with *Leishmania infantum*. In the case of *P. perniciosus* it was also shown that if the epipharnyx is infected flagellates are deposited during the act of feeding. Further work showed that flagellates from *P. perniciosus* when introduced into the skin of susceptible animals (*Cricetulus griseus* and *Citillus citillus*) produce visceral leishmaniasis. It was therefore concluded that *P. perniciosus* is a vector of Mediterranean kala azar.

Transmission by *P. perniciosus* cannot explain the whole of Mediterranean kala azar, for in material collected from Macedonia by officers of the R.A.M.C. during the War we did not find a single specimen of *P. perniciosus*, neither did we find this species in endemic foci in Syria.

On a recent trip through Greece no specimens of *P. perniciosus* were found, but in the neighbourhood of Argos, a heavy centre of infantile kala azar, and in Athens, where both infantile and canine kala azar occur, *P. major* was found to be common. Because of the purely nocturnal activity of *P. major* and its extreme photophobia after feeding, this species has been previously overlooked in Greece.

It was thought advisable to compare *P. major* and *P. perniciosus* as hosts of *L. infantum*. *P. major* is very rare in Malta, but is common in a limited area near Catania in Sicily. A dog naturally infected with kala azar in Malta was taken to Catania, and wild specimens of *P. major* and *P. perniciosus* were allowed to feed on the animal. Out of 31 specimens of *P. major* 25 became infected, while only 33 out of 119 specimens of *P. perniciosus* became infected. The behaviour of the flagellates in the two species was identical. It therefore appears that *P. major* is a better carrier of Mediterranean kala azar than *P. perniciosus* (assuming the identity of canine and infantile kala azar).

S. ADLER.

The Hebrew University,
Jerusalem.

O. THEODOR
(Kala Azar Commission
of the Royal Society).

[1] *Proc. Roy. Soc.*, B, **108**; 1931.

### The Expanding Universe

IN NATURE of July 2, Prof. Milne has published a very simple and attractive explanation of the phenomenon that has given rise to so much speculation among recent cosmogonists. The sole defect in his clear analysis is that the material particles that form the universe are taken initially to have been enclosed in some finite space, but without mutual action, or even collisions. I should like to bring to the notice of those interested that the last restriction may be easily removed.

Sundman, in his remarkable work on the three-body problem, showed certain general characteristics of the three-body system to persist under Newtonian laws of motion: that if the total energy is greater than that obtained by approach from infinity, under the mutual forces of attraction alone, then at least one of the three bodies will be ejected to infinity. Further, if the energy is less than this critical value and the particles at any time happen to be closer together than a certain determinate distance, the recession to infinity will again take place.

The importance of this lies in that the results can be immediately extended to the $n$-body problem, as has been demonstrated by Birkhoff, Chazy, Koopman, and others. By studying the Lagrangian $R$ function formed by the products of the masses with the squares of their mutual distances, it can be proved as before that two groups of the particles are to be distinguished: a slower set and a faster receding set; this, provided that the constant of energy is greater than a critical value, or in the contrary case, the $R$ function is sufficiently small at some time, a considerable number of the particles thus being very close together; regardless of the distribution in space or velocity. The further remarkable fact is that this characteristic of exterior motion seems to persist even for more general laws of force than that of the inverse square of the distance, provided that, for attractions, the force vanishes at infinity; certainly for laws of the inverse cube type, and some others.

Lastly, collisions present no difficulty, as the case of elastic rebound can be regularised for double collisions as for triple collisions by the method of Sundman, and collisions of order higher than two will be very rare indeed. This, with the case of Newtonian dynamics, is enough to show the generality of Prof. Milne's remarks. For the relativistic case, the results should be approximated, provided only a finite dissipation of the energy of the system takes place during

the motion, which is also taken to approximate to the Newtonian case as the density tends to zero.

I am, however, unable to say what the movement would be in case the masses at the centre occasion a 'horizon' of the de Sitter type. If electromagnetic components are present among the forces, the paths may remain bounded instead of receding to infinity, as such forces have a 'non-energic' component.

D. D. KOSAMBI.

Malleswaram, Bangalore,
July 28.

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IT is very satisfactory to find that the explanation I have given of the phenomena of the expanding universe can be freed from some of the restrictions which were introduced. The essential point in the explanation, as I pointed out, is that we have to do with an unenclosed system; if the system contains some high velocity particles, it will necessarily expand. Mr. Kosambi points out that the expansion and recession to infinity may also occur under more general conditions. But Mr. Kosambi is scarcely correct in saying that in my explanation "the material particles that form the universe are taken initially to have been enclosed in some finite space". I used the finite occupied sphere surrounded by infinite empty space as the most striking illustration of the principle (it was the way the explanation originally occurred to me), but as I explicitly pointed out, any 'initial' density distribution with a concentration towards one region will give rise to the expansion phenomenon; and for the particular relativistic world-structure which I outlined the initial density-distribution extends throughout *infinite* Euclidean space.

The statistical mechanics of an unenclosed system ("a gas-container with the lid off") requires detailed consideration, for it is significantly different from the statistical mechanics of an enclosed system. In particular, the entropy principle no longer holds in its usual form. Maxwell speculated on the consequences of the existence of a velocity sorter, a 'sorting demon'. An unenclosed universe is itself its own sorting demon, and the pessimistic conclusions of Jeans and others as to an inevitable heat-death for the universe must be viewed with doubt.

If point-events are ultimately found to be confined to a finite 3-spread, mathematicians will be entitled to describe the relationships of these point-events by means of a Riemannian metric; but observation has already compelled the introduction of an *expanding* 3-spread if this line of thought is to be retained, with its manifest difficulties, including the re-introduction of an absolute time. In the meantime I prefer to describe these relationships by means of the infinite Euclidean space of any one observer, together with his own particular time. To speak of 'space' itself as curved or finite is of course meaningless, for 'space' is no objective entity; space and time are merely the observer's dissection of that reality which is the change in the observed mutual relationships of observed material particles—what Bergson called "le devenir", or the process of becoming. To describe this reality we may adopt any conceptual space we choose, provided it has the correct number of dimensions.[1] The space of my first paragraph above is the conceptual Euclidean space of any one observer.

The most general scheme of matter and motion for the ground-plan of the universe, that is, the most general description of the above reality, consistent with the observed facts on which the special theory of relativity was based, appears to be given by the distribution-law (for any one observer)

$$F\left(\frac{Z^2}{XY}\right)\frac{dxdydzdudvdw}{c^6 Y^{\frac{3}{2}} X^{\frac{3}{2}}},$$

where $X$ is the invariant

$$t^2 - \frac{x^2+y^2+z^2}{c^2},$$

and $Y$ and $Z$ are respectively the covariants

$$1 - \frac{u^2+v^2+w^2}{c^2},$$

$$t - \frac{ux+vy+wz}{c^2},$$

$x, y, z, t$ being reckoned from the natural space-time origin of the observer. The distribution I gave in my synopsis (NATURE, July 2, 1932) was the particular case of rectilinear motions, for which

$$F \equiv \frac{\text{constant}}{[(Z^2/XY)-1]^{3/2}}.$$

In general to any function $F$ corresponds a definite acceleration of each material particle and curvature of world lines. The condition that the accelerations near ourselves, for small velocities, coincide with those predicted by the Newtonian law leads to the relation

$$\frac{4}{3}\pi G\rho = \frac{D}{t^2}$$

where $G$ is the gravitational constant, $D$ is a constant less than unity, $\rho$ is the present mean density of the smoothed-out universe near the observer, and $t$ is the observer's reckoning of the time that has elapsed from the space-time origin; $t$ is to be calculated from $V \sim r/t$ where $V$ is the mean observed recession-velocity at observed distance $r$. This evaluates $\rho$ as not greater than $10^{-27}$ gram. cm.$^{-3}$.

The possibility of the construction of a universe which appears to *every* observer to be completely centred round himself, wherever he be, and which at the same time thins away at great distances from himself, removes those difficulties which originally led Einstein to adopt a curved finite continuum for the description of the universe.[2] And the fact that we now observe recession-velocities comparable with that of light destroys any justification for the existence of a 'cosmic time', for there is no longer a co-ordinate system in which the observed velocities of celestial objects are all small compared with that of light.[3] In my opinion, these considerations remove many of the traditional philosophical difficulties concerning time and space as a means of description of matter and motion.

E. A. MILNE.

Wadham College, Oxford,
Aug. 19.

[1] Cf. Larmor, "Questions in Physical Interdetermination", *C.R. du Congrès Internat. des Mathématiciens*, 1920, p. 13.
[2] See Einstein, *Sitz. Preuss. Akad. Wiss.* (1917), 150, and "Relativity", English Trans. 4th edition, 1921, Part III.
[3] Cf. Einstein, loc. cit., Chap. 32, p. 113.

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## Inheritance of Acquired Characters

IN 1815, Lamarck propounded the hypothesis that all which has been acquired, laid down or changed in the organisation of individuals in the course of their life is conserved by generation and transmitted to the new individuals which proceed from those which have undergone those changes.

This doctrine is at present somewhat discredited and Prof. T. H. Morgan recently asserted that the stories in the folk-lore of primitive peoples which take for granted that acquired characters are inherited appeal to our sense of humour, and would long ago have been forgotten or disregarded by men of science were it not that in every generation new illustrations are continually brought forward.

In adducing such illustrations, the difficulty is to prove that the characters in question are outside the

scope of natural selection, that they are non-utilitarian and not correlated with any useful characters. This difficulty would appear to be obviated in the illustration which is now given.

It is noteworthy that many eminent men were begotten by fathers of ripe age: the father of Francis Bacon was fifty-two years of age, of John Herschel fifty-four, of Robert Boyle sixty-one, of William Pitt fifty-one, of Samuel Johnson fifty-three, of John Hunter sixty-five and of Charles Parsons fifty-four. This suggests that capability may be in some degree an acquired character, and that the older the father the greater the chance of it being acquired.

An attempt has been made to determine whether

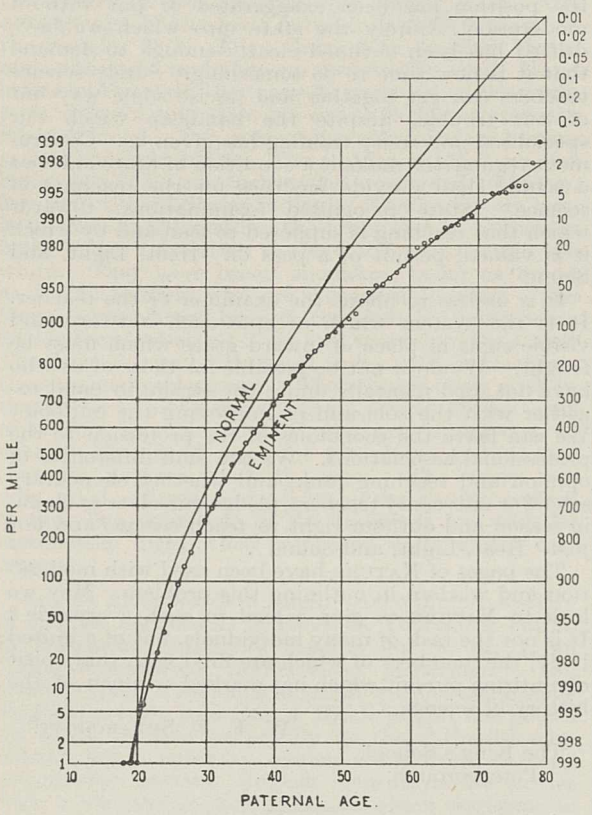


FIG. 1.

this can be substantiated. In the "Encyclopædia Britannica" (Fourteenth Edition) one thousand persons are noticed (exclusive of those mentioned on account of inherited titles) for whom the date of the father's birth is given. These are considered to be of outstanding capability and the paternal age has been compared with that for a more normal population.

The comparison has been made by plotting upon permille paper [1] the frequency distribution of the paternal age both for the eminent thousand and also for one hundred thousand children under one year recorded in the census of Scotland for 1921 (see Fig. 1).

This simple investigation appears to show that capability is an inheritable character acquired by those of mature years. The difference between the two curves in the figure is so striking—the proportion with paternal age more than forty-five years is twice, more than sixty years ten times, and more than seventy years fifty times the normal—that it is thought well to publish the facts without proceeding to examine other statistics.

In compiling the data, it was observed that the grandfathers of many eminent men were of ripe age; Ruskin's father, who was only thirty-five years of age, was born when his father was fifty-three years of age.

A. F. DUFTON.

Greenbank, Garston,
Hertfordshire, Sept. 1.

[1] *Phil. Mag.*, **10**, 556; 1930; and **11**, 454; 1931.

### Observations on Filmed and Filtered Vowels

REFERRING to Mr. W. E. Benton's letter on vowel sounds,[1] there is a further point to which attention may be directed, namely, the effect of the changes of attitude or 'expression' of the larynx and adjoining parts which accompany vowel formation.

At the International Phonetic Congress at Amsterdam, last July, Dr. Oscar Russell demonstrated the action of his own larynx while articulating various vowel sounds. It was evident that the laryngeal region is very active, and shows a different attitude at each change of vowel.

On the other hand, as Mr. Benton points out, the behaviour of my models showed that recognisable vowel sounds are produced by passing the vibrations of a reed through a pair of suitably tuned resonators in series. It also showed that a complete range of voiced vowel sounds could be produced, over a considerable musical range in each case, by simply altering the effective length of the vibrating reed.

The elaborate adjustments of the laryngeal region are evidently not essential to vowel production; they probably assist by providing in each case a fundamental vibration having overtones in the regions of frequency characteristic of the vowel in question.

Dr. Russell also articulated—in a whisper—some of the so-called voiced and unvoiced consonants (B, P; V, F), and it was apparent that, in this case also, the laryngeal region takes an active part in differentiating the 'voiced' from the 'unvoiced' sound, when both are whispered. This, incidentally, confirms the conclusion which I had drawn [2] from the behaviour of models.

The exact nature of the human adjustments requires investigation.

At my request, Dr. Russell also varied his facial expression while I watched his larynx. It was seen that at each change of facial expression—from a smile to a scowl, for example—there was also a change of expression in the laryngeal region.

This correlation—which also needs detailed investigation—offers a simple explanation of the emotional language of phonation, and completes the gestural picture of human speech.

The mouth gestures of articulation correlate with pantomimic hand or bodily gesture, and the changing attitudes of the laryngeal region correlate with changes of facial expression.

R. A. S. PAGET.

1 Devonshire Terrace,
London, W.2, Sept. 13.

[1] NATURE, Sept. 24, p. 475.
[2] *Proc. Roy. Soc.*, A, **114**, 98; 1927.

### Electron Oscillations

LAST year I made a series of observations on short-wave oscillations in three-electrode valves with positive grid. Details of the experiments will be published elsewhere, but a brief account here, in relation to a theory on the mechanism of these oscillations, as electron oscillations, which I have worked out recently, may prove interesting.[1]

The experimental arrangement was similar to that used by most workers,[2] differing only in a few details.

A system of parallel wires was attached to the grid and plate terminals of the valve. For every position of a movable condenser joining the wires there was a definite pair of values for the grid potential $V_g$ and the emission current $i_e$ which set up oscillations of maximum strength. From $V_g$ and $i_e$, and from the construction data of the valve, it is possible to calculate the total number $N$ of the electrons between grid and plate.[3] In Fig. 1 the observed wave-lengths $\lambda$ are plotted against the values $1/\sqrt{N}$ for the following valves: Philips D II, Z I, TA 0810, Radiotechnique R 5, Zenith W 20 A.

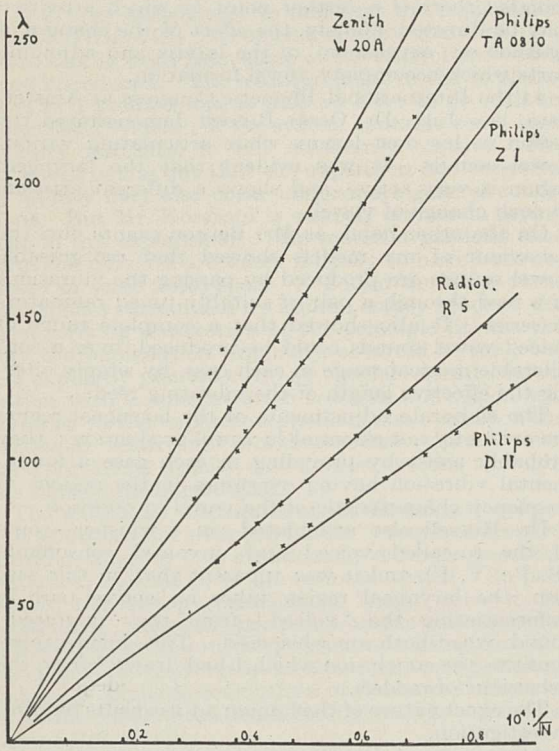


FIG. 1.

The experimental data seem to follow closely enough the theoretical relation $\lambda\sqrt{N} = \text{const} = K$. The values of the constants $K$ for different valves (representing the tangent of the straight lines in the figure) are in reasonably good agreement with the theoretical value (calculated for parallel plane electrodes, omitting space charge effects) $K = 3{\cdot}35 \times 10^5\sqrt{v}$, $v$ being the volume comprised between grid and plate of the valves; this is shown in the following table:

| | $v$. | $K$. | $K/\sqrt{v}$. |
|---|---|---|---|
| Phil. D II . . | 0·35 | $1{\cdot}42 \times 10^6$ | $2{\cdot}40 \times 10^6$ |
| Rad. R 5 . . | 0·47 | $1{\cdot}76 \times 10^6$ | $2{\cdot}57 \times 10^6$ |
| Phil. Z I . . | 1·00 | $2{\cdot}59 \times 10^6$ | $2{\cdot}59 \times 10^6$ |
| Phil. TA 0810 . | 1·16 | $3{\cdot}06 \times 10^6$ | $2{\cdot}84 \times 10^6$ |
| Zen. W 20 A . | 1·50 | $3{\cdot}60 \times 10^6$ | $2{\cdot}94 \times 10^6$ |

ANTONIO ROSTAGNI.

Physical Institute,
University of Turin,
July 31.

[1] *Atti R. Acc. Sc., Torino*, **66**, No. 1, p. 123; No. 2, p. 217; No. 3, p. 383; 1931. E. W. B. Gill (*Phil. Mag.*, **13**, 734; 1932) seems not to have noticed that in these papers I showed in particular how the condition for the maintenance of the oscillations $\int eidt < 0$, is satisfied (No. 1, p. 128; No. 3, p. 393).
[2] See, for example, E. W. B. Gill, *Phil. Mag.*, **44**, 161; 1922.
[3] *Atti R. Acc. Sc., Torino*, **66**, No. 1, p. 123; No. 3, p. 383; 1931.

## Science Teaching in Schools

IN several recent issues of NATURE it is suggested that the science teaching in schools is lifeless and dominated by the curse of useless external examinations. I learn that as a result there is little scientific interest or knowledge among the masses, and finally I am cast down by a fearsome picture of the horrors of the machine which science has created.

Turning for consolation to educational periodicals and my colleagues, I find the same story and an atmosphere of desolation such as one associates with a Russian novel.

Unfortunately, this is all true. I cannot say that the position has been exaggerated or put without moderation. Surely the state into which we have drifted has been outlined clearly enough to demand that it is now time to *do* something. Surely science teachers can get together and devise some way out of our trouble, despite the handicap which our specialised university training has given us. Government regulations make it a condition of State aid that a school shall provide facilities for the teaching of science. State-recognised examinations, towards which that teaching is supposed to lead and by which it is valued, permit of a pass on 'Heat, Light, and Sound'.

It is useless to blame the examiner or the teacher. It is the system which accepts such outward and visible signs in place of inward grace which must be fought. Would it not be possible for those of us who have not died mentally under the strain, to band together with the sole aim of improving the outlook? We can leave the economics of the profession to the professional associations. We can sink differences of opinion and teaching rank, and whether elementary school or university teachers, pledge ourselves to claim, in season and out, our right to teach science and not just 'Heat, Light, and Sound'.

The pages of NATURE have been used with moderation and wisdom in outlining this problem. May we look to NATURE to give a lead to such a crusade? It is not the task of many individuals, but of a united body, the members of which are fired with that spirit of untiring pursuit which has marked so much of the history of science.

W. F. F. SHEARCROFT.

The King's School,
Peterborough.

## The Sense of Smell of Cats

I HAD a favourite cat which was having fits and becoming dangerous, so, to destroy it as painlessly as possible, I inserted several grains of morphia in the centre of a piece of foie gras which was cut in two, great care being taken that no morphia was spilt on the outside. The cat on being shown the foie gras expressed in every way its eagerness for it, but when it got within three feet of the foie gras, turned round and looked at me with intense astonishment, and then after another sniff walked away, though previously it had always worried for a small piece. The special point is that the cat could detect something dangerous through the strong smell of the foie gras, though morphia, even in considerable quantities, has to most persons only a faint odour.

F. W. EDRIDGE-GREEN.

99 Walm Lane, Willesden Green,
London, N.W.2,
Sept. 13.

## Research Items

**Anthropometry of the Maya Indians.**—In accordance with the policy of the Carnegie Institution (Washington) for making Chichen Itzá, Yucatan, a focal point for correlated research in the archæology, anthropology, linguistics, and biology of Yucatan, Dr. Morris Steggerda, of the Department of Genetics of the Carnegie Institution, has undertaken a study of the physical and physiological characters of the Maya of the villages in the neighbourhood of Chichen Itzá (Publication No. 434, Carnegie Institution). 77 males and 56 females were examined, also 135 children; but the report on the children will appear later. The average age of the male subjects was 30·6 years, of the females 28·8. They claimed to be pure Maya, and although probably no genetically pure Maya exists in Yucatan, they may be regarded as relatively pure, with not more than one-eighth to three-sixteenths Spanish blood. The average eye colour is dark brown, and of the hair, black. The stature is 155·2 cm. for males and 142·8 cm. for females, a range of 10-15 cm. less than United States Indians. Their arms are long in relation to the stature, the lower arm in particular being longer in relation to the whole arm than in the white. They have broad shoulders, being as broad as Plains Indians, who are considerably taller. The Maya is very broad-headed, the cephalic index being 85, the females being 1-2 per cent more than the males. The face is broad, the nasal index still leptorrhine, the ears long and narrow. The relative chest girth in the Maya is astonishingly great, being 56 per cent of stature in males and 58 per cent in females, as against 53 and 55 per cent for whites and 51 per cent for negroes of both sexes. The teeth are very good, 42 per cent of 88 adults having perfect teeth. The pulse rate of the Indian is low and the metabolism high, when compared with whites and negroes.

**English Loan-words in Hindi.**—According to a study of English loan-words in Hindi by Dhirendra Varma in *Allahabad University Studies*, vol. 8, pt. 1, an "English-educated middle-class gentleman" can scarcely speak a sentence in Hindi without using some English words; and thus a Hindi jargon has grown up which is used invariably by the "English-educated" when speaking among themselves. Among uneducated Indians, English loan-words are in use with a vernacular pronunciation, which conforms to certain phonetic rules or principles. From the point of view of meaning, these words may be classified under certain main heads: (1) words used to convey ideas connected with foreign institutions, such as courts and offices, military and police, educational system, transport and communications, for example, kālij (college), injīniar (engineer), ōbarsiar (overseer); (2) articles introduced by foreign influence—dress, food and drink, machinery, objects of recreation, for example, burus (brush), baeslin (vaseline), timātar (tomato), pancar (puncture). In phonetics, an unfamiliar English sound is replaced by the nearest Hindi sound, while in some cases awkward sounds are dropped or new sounds are introduced to facilitate pronunciation, for example, engine becomes anjan, officer, āphsar; diphthongs are converted into simple vowels, for example, paetmaen, pointsman; a vowel appears to avoid conjunct consonants, phāram, farm, kilark, clerk; or by prothesis, istēsan, station, iskūl, skull, astabal, stable. In consonantal changes, cerebral or dental sounds are substituted for English alveolars, for example, darjan, dozen, Sitambar, September; *c* and *j* are substituted for *t*, *f*, and *dz*, for example, cāk, chalk; *f* and *th* are changed to the nearest stops, that is, *ph* and *th*, for example, phutbāl. By metathesis, general becomes jarnael, and signal singal; *l* is substituted for *n*, for example, lambar for number, and lemonade becomes lamlēt or laemunaṭ, and so forth. The loan-words are mostly nouns. Neuters are assigned to masculine or feminine indifferently; while for purposes of declension English loan-words are treated like Hindi nouns. A full list of loan-words is appended.

**Carbohydrates in Relation to Disease.**—The abundance of cheap sugar is not only an embarrassment to the sugar industry, but, according to Dr. J. H. P. Paton, also brings risks in connexion with disease (*Edin. Med. J.*, **39**, No. 9, p. 556). Dr. Paton estimates that the average consumption of sugar is now in the neighbourhood of 100 lb. a head per annum. Sugar, as we use it, is not a natural food, and is devoid of all accessory food substances. Excessive consumption of sugar tends to upset digestion, is a factor in the production of rickets and dental decay, and leads to retention of water in the body, with an increased tendency to catarrhal affections. It is probably responsible for the increasing frequency of acidosis in the modern child, and it throws additional work on the pancreas, which may result in degeneration of this organ and diabetes. Experimentally, an abundant supply of glucose promotes the development of cancer in mice, and carbohydrate excess may therefore be one of the factors causing the increased prevalence of cancer.

**African Birds and Temperature.**—Dr. F. M. Chapman has shown that the distribution of bird-life in South America can be associated with climatic zones related to temperature, and applying a similar analysis to the birds of Africa, W. Wedgwood Bowen has found a zoning comparable to that in South America (*Proc. Acad. Nat. Sci. Philadelphia*, **84**, 259; 1932). Knowledge of the distribution of many species is too inadequate to permit a thorough analysis of the zonal relationships; but, ignoring the alpine and temperate zones, a rough analysis shows that 599 species are limited to the tropical zone and 550 to the subtropical zone, while only 100 occur indifferently in both zones, although 254 more which are common to both zones show subspecific differences which appear to be related to temperature. That is to say, of 1500 species only 100 appear to exhibit no change attributable to temperature. Although the distribution of the vegetation belts in Africa is mainly determined by rainfall, yet the study of Shantz's vegetation map shows that, with one notable exception, each of the various vegetation types may be classified roughly according to life zones (apparently not a chance distribution), and even the exception, the "acacia—tall grass savanna", which ranges widely through tropical and subtropical zones, may, the author thinks, be divisible, from the point of view of bird distribution, into tropical and subtropical portions.

**Butterflies of the District of Columbia.**—Bulletin 157 (1931) of the United States National Museum is devoted to an extensive memoir (366 pp.) entitled "The Butterflies of the District of Columbia and Vicinity". Its author, Mr. Austin H. Clark, who is curator in the Museum, has in this work provided an admirable non-technical guide to the rich butterfly fauna of the area under consideration. Each species is discussed at variable length, according to any special features of interest associated with it. Also, each species has one or more illustrations devoted to

it, and these figures are comprised in some sixty-four half-tone plates bound at the end of the letterpress. In the long introductory chapter the author contributes a number of interesting remarks and observations on butterfly behaviour. Of especial note is the section dealing with pressure of population, since, in many of the species, he finds that if the males increase beyond a certain proportion they seem incapable of living amicably together in the presence of the females. A familiar sight is a shrinking puddle tenanted by gay companies of newly emerged male butterflies. These, according to the author, are examples that have been driven from over-populated areas by being incessantly tormented by other males. Requiring water, these fugitives naturally resort to the moisture found in puddles, where, in the absence of the females, they exist peaceably. Many of the common roadside butterflies are also stated to be exiles and consist of newly emerged males. They appear to be unable to cope with the older males in their natural habitats and are driven to areas beyond where the females live. As they mature, and the older males die off, they are able to fly back to the fields and, in their turn, drive out any younger and less lusty rivals. Sections devoted to butterflies and storms, the extermination of one species by another, migration, and other features of the biology of these insects are also included in this paper.

**Storage of Fruit by Freezing.**—Dr. J. Barker and Mr. T. Morris have just published a very interesting leaflet on the comparative values of different methods of storing fruit by freezing (Dept. Sci. and Ind. Res. *Food Investigation Leaflet* No. 2, 9 pp., 1932). The principles and practice of preservation by cold storage are discussed. Freezing alone often results in an inferior product due to the activities of enzymes when thawing takes place. Refrigeration with sugar or syrup prevents the browning of such fruits as plums and cherries during storage, and the destruction of the enzymes of peas or beans by heating slightly before cold storage gives successful results. Quick freezing and freezing in a vacuum or under an inert gas have also been investigated. The special considerations relating to the cold storage of English plums are set forth by Dr. Franklyn Kidd and Dr. C. West in *Leaflet* No. 1 of the same series (6 pp., 1932). The effects of storage temperature, handling, fungal rotting, packing, type of store, and climatic conditions before harvesting are all discussed. The report, though short, gives the results of ten years' intensive work upon the problem.

**Bacteriophage of *Pseudomonas radicicola*.**—An interesting paper entitled "Studies on Bacteriophages of the Root Nodule Organisms", by Dr. S. V. Desai, dealing with the effect of certain bacteriophages on the activity of the root nodule organisms of leguminous plants, has recently appeared (*Indian J. Agr. Sci.*, vol. 2, pt. 2., 1932). Several strains of bacteriophage were isolated, and it was found that media which were suitable for initial separation were not good for the increase of virulence of the bacteriophage. The different strains were not specific for the various strains of the bacterial host, and it is suggested that there is only one bacteriophage for *Pseudomonas radicicola*, no matter what its host plant may be. The lytic principle was inactivated by heating to 75° C. for five minutes. The results suggest further experiments to determine what part the bacteriophage plays under field or garden conditions. It has been found difficult to separate the organism and its bacteriophage, and it seems possible that the presence or absence of the latter may bear an intimate relation with the observed behaviour of the former.

**Correlation of Coal Seams by Plant Spores.**—The correlation of coal seams has usually depended on consideration of the associated shales and, in particular, the fossil-bearing bands. One of the most characteristic features of coals are those plant remains which have escaped destruction in the process of coal formation. Of late years, the means for identifying and even isolating the spore exines which are resistant to decay have been perfected and thus provide a method of correlation which may offer advantages over the study of fossils in adjacent strata. This method has been applied to the Parkgate seam in the Yorkshire area, and the Fuel Research Division of the Department of Scientific and Industrial Research has now, in Paper 23 of the Physical and Chemical Survey of National Coal Resources entitled "The Significance of Spores in the Correlation of Coal Seams" (H.M. Stationery Office, 2*s*. net), reported the extension of the study to the Barnsley and Silkstone seams in the same area. In all, 30 types of spore have been distinguished, and although most of them are too few in number or too irregular in distribution to use in identification, there is evidence that certain types are characteristic of certain seams, and the force of these conclusions may grow with increase in the number of observations.

**Swedish Rainfall.**—The report of the Swedish rainfall stations for 1931 has been published by the Statens Meteorologisk Hydrografiska Anstalt in the Årsbok, No. 13, pt. 2. The data come from 698 stations spread throughout the State. Their distribution is shown on a large-scale map. For every month in the year there is a detailed record of every station and a map of the rainfall. The year proved to be exceptionally wet, with a rainfall that averaged 142 per cent of the normal over the whole country. Only two provinces had a year's total below the average, and many had more than twice the normal rainfall. On the whole, the northern parts were the driest and the areas of the central depression the wettest.

**Existence of a Heavy Lead Isotope.**—K. Murakawa has published recently a note on the hyperfine structure in the spectrum of lead (*Scientific Paper* No. 371, Tokyo) which illustrates both the value and difficulty of such work. In it he confirms the existence of the light lead isotope $Pb^{204}$ found by Schuler and Jones in a similar manner, but also claims, in opposition to Kopfermann, that there is a satellite to λ4057 which must be attributed to a heavy isotope $Pb^{210}$. He finds similar satellites to λ3683 and λ4387. A Lummer-Gehrcke interferometer pattern for 4387 is reproduced showing the supposed $Pb^{210}$ component, although without the corresponding microphotometer record. The abundance ratio for $Pb^{204}$ and $Pb^{207}$ is given as 1 : 25, and the ratio for $Pb^{204}$ and $Pb^{210}$ as 8 : 1.

**Thermionic Emission.**—The subject of thermionics has developed in a few years from the method of studying the electrical properties of matter to being the basis of one of the world's widest commercial applications of physical science. Richardson was the first to state, thirty years ago, that electrons, normally retained in a substance by a potential discontinuity at its surface, are able, when the body is heated, to escape through the surface and so constitute an electric current. The literature of the subject is now widespread and much of it is very abstruse. It was decided by the Radio Research Board that a critical survey of the literature would be of real value to engineers and other scientific workers. The work was entrusted to Dr. W. S. Stiles, of the National Physical Laboratory, and is now published (Radio Research Report No. 11. London: H.M.S.O., 2*s*. 6*d*.). The author

gives a clear and comprehensive survey of all the main results obtained in researches in the various branches of the subject, together with a lengthy and carefully compiled bibliography, which includes references to all the important papers published up to December 1930. This book will prove of great value to everyone interested in thermionics. The author sometimes gives useful hints showing how formulæ given by different authors can be reconciled. His abstracts also will enable the investigator to see what original papers he should consult.

**Highly Cracked Gasoline.**—In the April number of *Industrial and Engineering Chemistry*, Messrs. C. R. Payne and Alexander Lowy give an interesting account of their work on the study of composition of cracked petrol before and after heat-treatment. Their method, briefly, was to subject this petrol to a temperature of about 300° C., which is actually below the temperature employed in the cracking process, and they reached some interesting conclusions. It was found that the percentage of unsaturated hydrocarbons was decreased by the heat and pressure treatment in all the fractions isolated. The percentage of naphthenes in the whole distillate up to 201·5° C. was increased by the treatment. Additional changes are considered to be attributable to polymerisation, such as increase of material boiling above 201·5° C. by about 4 per cent; disappearance of probable presence of cyclo-alkenes; and formation of hydrocarbons containing hydrogen atoms easily replaceable by halogen. Regarding the composition of the cracked petrol, benzene and toluene were identified in selected fractions; in one fraction, boiling from 20·4° to 35° C., the presence of methylcyclobutane was inferred. A further interesting point is that, in general, the proportion of unsaturated hydrocarbons tends to decrease as the boiling point increases; while in a similar way, the proportion of paraffinic hydrocarbons decreases, and the percentage of naphthenes and aromatics increases, as the boiling point is raised. Although the paper is a comparatively short one, it contains some valuable data on the physical and chemical properties of the various fractions, not easily accessible elsewhere; in particular, the refractive indices on ordinary and treated fractions provide some interesting contrasts.

## Astronomical Topics

**The Total Solar Eclipse of Aug. 31.**—Further bulletins from Science Service, Washington, indicate that several observing parties obtained a fair measure of success. The U.S. Naval Observatory party at Limerick, Maine, was able to carry out its full programme, though thin cirrus cloud was passing. The General Electric Company sent up an aeroplane at Concord, N.H., which reached perfectly clear sky; the moon's shadow was seen for three minutes before and after totality. The Harvard party at Portland, Maine, had a completely clear sky. The Greenwich party at Parent obtained a satisfactory photograph of the flash spectrum extending from $H_a$ to the $H$ and $K$ calcium lines; but the attempt to obtain the infrared portion failed.

At least three different parties of observers, seeing that conditions at their stations were almost hopeless, made dashes by motor cars to regions where the clouds were less dense, and were successful in obtaining views of the eclipse, though of course there was not time to transport large instruments. Excellent roads contributed to the success of this novel resource.

**Astronomical Notes for October.**—Venus is well placed for observation as a morning star in Leo; it has passed its greatest brilliance, but is still of magnitude −3·7. The illuminated fraction of the disc increases from 0·62 to 0·73, the diameter diminishes from 19″ to 15″. There is a conjunction of Venus and Jupiter (distance apart 7′) on the morning of Oct. 20; they will be high enough for convenient observation soon after 4 A.M.; it will give an opportunity to compare their surface brightness, and hence their albedoes.

Mars is a morning star, moving from Cancer to Leo; its diameter increases from 5″ to 6″; it will be nearly 14″ at the nearest approach to the earth on March 3. Mars will remain fairly near Jupiter throughout this apparition; their least distance apart will be 16′ on June 4. Mars will make a near approach to the moon's south limb at 6.40 A.M. on Oct. 24 next. There will be an occultation in Scotland.

Saturn is still observable in the early part of the night; it is stationary in the eastern part of Sagittarius. The ring has begun to close; its major axis is 38″, its minor 14″; it will be edgewise about the end of 1936.

Uranus is well placed for observation, being in opposition on Oct. 14; it is in the eastern part of Pisces; its diameter is 3·6″; a map of the faint stars near it is given in the B.A.A. Handbook for 1932. Its magnitude is 5·9, so that it is visible to a good eye.

There are two occultations of fifth magnitude stars visible in London; one disappears on Oct. 11 at 6$^h$ 58½$^m$ P.M., 40° from the north point; the other reappears on Oct. 20 at 2$^h$ 36½$^m$ A.M., 230° from the north point.

Comet Peltier-Whipple was visible to the naked eye at the end of August; it is now fainter, but still observable with moderate telescopes; the following ephemeris (for 0 hours on the days named) is a continuation of one by Messrs. Anderson and Cherrington (Harvard Card 239).

| | R.A. | N. Decl. |
|---|---|---|
| Sept. 30 | 13$^h$ 47$^m$ 21$^s$ | 56° 40′ |
| Oct. 4 | 13 52 52 | 54 37 |
| 8 | 13 57 36 | 52 49 |
| 12 | 14 1 39 | 51 15 |
| 16 | 14 5 18 | 49 52 |
| 20 | 14 8 36 | 48 40 |
| 24 | 14 11 40 | 47 36 |
| 28 | 14 14 31 | 46 41 |
| Nov. 1 | 14 17 12 | 45 55 |
| 5 | 14 19 41 | 45 17 |

Ephemerides for several periodic comets now under observation are given in the B.A.A. Handbook for 1932. It is to be hoped that all who have the means will join in the search for Tempel's comet of the November meteors; if the estimated date of perihelion is near the truth, it would be in Cancer or Leo during October. Search should also be made for Brooks's comet; it is in Pisces, and should be nearly midway between the two ephemerides given in the Handbook.

The most conveniently observable minima of Algol occur on Oct. 11 about 10$^h$ 36$^m$ P.M., and on Oct. 14 about 7$^h$ 24$^m$ P.M.

Summer Time ends at 2$^h$ A.M. on Oct. 2; after that date the times given here are those shown by ordinary clocks. It is well to note that astronomical records should never be made in Summer Time, but always in true Greenwich time.

## Forestry in Mauritius

CONSIDERABLY more than twenty-five per cent of the island of Mauritius is occupied by forests and rocky mountains which lie outside the cultivated area. As is pointed out in the Annual Report of the Forest Department of Mauritius for 1930, the great density of population, the small area of the forests (Government forests, Crown and other forest lands, total 92,050 arpents or about 95,732 acres) and the demands made upon them, the many uses to which wood is put, and the local dependence on imported timber, all point to the vital importance of forestry in the island. Since the forests lie mainly on the top and slopes of the central plateau, from which all the important rivers run, it is obvious that their preservation is equally vital to the maintenance of the premier industry of sugar cultivation, in order to prevent erosion and its destructive aftermath, and to secure the maintenance of water supplies, and so forth.

During the year effect was given to a scheme of reorganisation of the Department, in order to introduce better methods of control and to permit of future development. It is unfortunate that this scheme, which reflects the highest credit upon its authors, should have so nearly coincided with present financial stringency. Nevertheless, when the chief commercial interest of the Colony is so intimately bound up with its forests, it may be confidently expected that the recognition accorded to the importance of the Forest Department may not be withdrawn owing to what, it may be hoped, is a temporary financial embarrassment.

The climate of the central plateau of the island is cool, windy, and wet. The two southern masses of forest are by far the largest, and from them the Grand Bassin Division (30,000 arpents) and the Midlands Division (21,000 arpents) have been formed (1 arpent equals 1·044 English acres). The northern block of forest comprises the Nouvelle Découverte Division, of about 5700 arpents. The Divisions are mainly State forest, with some privately owned mountain reserves along the boundaries. Grand Bassin Division contains 2800 arpents of mountain reserves, Midlands Division 500 arpents, and Nouvelle Découverte Division 1000 arpents.

About one-half of the staff is engaged outside the forests in protecting the mountain, river, and road reserves, administering the laws governing those reserves, working the small isolated State forests, and inspecting leased Crown lands, notably a strip of land round the coast, known as Pas Géométriques.

Forest management is under the control of a Forest Board, which held seven meetings during the year, the subjects under consideration consisting of the working of the land purchase scheme, the management of the mountain reserves, and the forms of lease for the Pas Géométriques.

A considerable amount of forest survey work was undertaken, 500 miles of boundary lines cleaned of weeds, and stock maps of the growing stock on 3470 arpents of forest prepared. Roads and a tramway line were also under construction to facilitate the extraction of timber and fuel.

Experiments in afforestation work and the rearing of exotics have been in hand for some years, and recently this work has made great strides. Wide spacing was formerly made use of in plantations, but the policy is now to plant closer, and a considerable amount of work in filling up the old wide-spaced plantations has had to be undertaken in order to obtain satisfactory crops. Tending the new plantations is also given careful attention, and plantation control books have been introduced, the officer concerned filling up data of growth and so forth twice in the year—a most excellent provision. On the subject of this work, the conservator, Mr. G. N. Sale, writes: "During the past fifty years numerous species [of exotics] have been tried, and many found to be suitable for plantations. This work was continued in 1930, and success was obtained in the nurseries with *Pinus caribœa*, which germinated and grew even better than *Pinus tœda*. It is to be hoped that this valuable tree will prove as vigorous in the forest as in the seed-bed. *Pinus palustris* formed luxuriant foliage, but no leader. *Pinus sylvestris*, *Sequoia sempervirens*, and *Ormosia semicastrata* failed in the Nursery."

Animals, especially deer, and weeds appear to be the chief dangers which the forests have at present to fear. It is said that "the number of deer is kept as high as possible by the Lessees of the Shooting Rights over nearly the whole of the State forests". It is not stated what rent is obtained from the lessees; in the latter part of last century, when the King of Saxony desired to have an excessive number of deer maintained in the State forests, he paid a considerable rent for the feeding of the animals during the winter months, and for excessive damage done, in addition.

Under the heading of utilisation, some interesting information is given on the subject of timber and fuel. Most of the timber obtained during the year came from Belle Rive, in Midlands Division. "The timber was extracted partly in the form of logs, which were sent to the Match Factory. Pine scantlings were sold to the Harbour Engineer, who worked the timber, soaked it in fuel oil and used it in the Granary. This form of impregnation was adopted by the Forest Department, and the results will be watched with interest. If the Chinese Pine timber can easily be rendered immune from the attacks of White Ants, the plantations made from 1885 onwards should supply material of the greatest value to the Colony during the next twenty years. The Pine timber proved fairly satisfactory in seasoning, and did not split and twist to any great extent, but the timber of *Eucalyptus robusta* was very difficult to season." The forest felled was apparently patchy; eucalyptus had outgrown the pine, developing large spreading branches. The timber not being straight-grown, it warped and split badly, especially when sawn into boards and planks. Straight-grown eucalyptus, especially *E. tereticornis* and 'E. hybrid', would, it is believed, yield very good boards when carefully seasoned. It is stated that the demand for indigenous timber is steady, if not large; 'plantation timber' of exotic species is much less popular. "It will not be possible to produce any considerable supply of indigenous timber, and it is hoped that when the public becomes accustomed to well seasoned exotic timber, this prejudice will disappear."

Whilst it is obviously to the interest of the Colony to endeavour to raise in plantations such a proportion of exotic timber material as will reduce the imports, yet the neglect to maintain and obtain the regeneration of at least a portion of the indigenous forests would not, we believe, be in the true interests of the Colony or its future. An entire reliance on introduced species is dangerous, and is probably uneconomic in the long run.

A suggestion might be proffered on the subject of the tabular statements in the appendix series. These are not in some cases easy to follow, and in Appendix 9 no totals are given. A statement of the imports of timber and other forest produce into the Colony would be useful. With this minor criticism, it may be said that the Report under review has many points of unexpected interest, and reflects credit upon the Governor, the Forest Board, and the Conservator.

## Lighting and Light Sources

AMONG the papers presented in Section 6 of the International Electrical Congress, recently held in Paris, was one by Dr. Pirani, of the Osram Gesellschaft, who gave a very interesting account of recent developments in the production of light. After a general description of the underlying principles of the modern discharge tube, he dealt in more detail with the two types showing the greatest efficiency, namely, the sodium tube and the mercury tube. In the case of the former it has been found experimentally that the addition of one of the rare gases at a pressure about a thousand times as great as that of the sodium vapour is of considerable advantage. Since the atoms of the rare gas require a very high voltage to excite them, they act principally as elastic obstacles in the path of the electrons and so increase a hundred-fold the distance which an electron travels on its journey from the cathode to the anode. The chance of a collision between the electron and an atom of sodium is thus correspondingly increased. When the tube is operating under the most favourable conditions, 70-80 per cent of the energy of the electrons is transformed into light. An over-all efficiency of about sixty lumens a watt can be obtained from a sodium tube.

In the case of the mercury tube, the intensities of the lines in the longer wave-length part of the spectrum are much increased, relatively to the others, by increasing the pressure in the tube to one atmosphere or more. This is illustrated by diagrams showing the relative intensities of the different lines for two tubes operating at pressures of 0·5 mm. and 3 atmospheres respectively. The result is naturally a very great increase in luminous efficiency and lamps can be operated to give 50 lumens a watt. The possibilities of light production by the excitation of gases in the molecular state, and of liquids or solids, are discussed by the author in a final section of his paper, but he concludes that the most hopeful line of work lies with gases in the atomic state or with vapours.

A new type of mercury arc in quartz, stated to have an efficiency of some 10 candles a watt, was described in a paper by Prof. Cz. Reczynski of Poland. It depends on the reduction of the cathode potential drop from 100 volts to about 5 volts by (*a*) using for the cathode a ball of tungsten instead of mercury, and (*b*) placing a tungsten filament at a short distance away from the cathode.

In an interesting communication from Japan, Dr. R. Kurosawa described a method of studying the characteristics of a diffusing material, as regards transmission and reflection. The brightness (not the candle-power) of a sample of the material is measured at all angles of view, the light being incident normally. The measurements are most conveniently carried out by means of a photoelectric cell (that employed by the author is a vacuum type cæsium cell), an image of a given area of the surface of the material being formed on the sensitive surface of the cell. The author recommends Halbertsma's definition of diffusing power ($\sigma$), that is,

$$\sigma = \sum^{n} \beta(\theta)/n\beta(o)$$

where $\beta(\theta)$ is the brightness at an angle $\theta$ to the normal and $n$ is the number of directions in which measurements are made. The author considers that three measurements, at the angles $22\frac{1}{2}°$, $45°$, and $67\frac{1}{2}°$, are generally sufficient. Since $\beta(o)$ cannot be obtained by direct measurement in the case of reflection, it must be deduced by extrapolation from observations made at the above three angles, using Lagrange's formula $\beta(o) = \sum^{3} R_i \beta\left(\frac{i\pi}{8}\right)$ where $R_1 = 1{\cdot}5412$, $R_2 = -0{\cdot}6682$, $R_3 = 0{\cdot}1270$. A nomogram is given in the paper for finding $\sigma$ from the observed values of $\beta_2/\beta_1$ and $\beta_3/\beta_1$, using the formula deduced by the above method, namely,

$$\sigma = (\beta_1 + \beta_2 + \beta_3)/(4{\cdot}62\beta_1 - 2{\cdot}00\beta_2 + 0{\cdot}38\beta_3).$$

The subject of glare in lighting installations was considered in two papers presented in this section. M. J. Dourgnon, defining glare as the threshold sensitivity of the retina at a given point $A$ (for example, the fovea) with the eye exposed to any given field, proposed that the glare produced by a uniform field having a brightness equal to 1 candle per square cm. should be adopted as the 'unit of glare'.

Ing. J. Ondracek, of Austria, dealt principally with the time required for the eye to adapt itself when the gaze was transferred from a surface of high brightness to one of low brightness, or vice versa. This time is a function of the *average* brightness of the two fields of view and may be expressed in terms of the ratio of these two brightnesses. In the practical case, one brightness is that of the surface being worked upon, while the other is the average brightness of the surroundings, for example, ceiling, walls, and floor.

The use of photoelectric cells for colorimetry was described in a paper by Dr. N. R. Campbell, who outlined the method of colour-matching electric lamps by the use of two cells having markedly different sensitivity curves, and the use of the Toussaint photoelectric colorimeter for giving a rough indication of the spectral distribution of the light reflected from a coloured surface.

## Evaporation, Condensation, and Adsorption

DR. I. LANGMUIR (*J. Amer. Chem. Soc.*, July) has extended his well-known adsorption formula by taking account of the forces between adjacent adsorbed particles ('adatoms'). In the simple theory, the rate of evaporation of adatoms from a surface is $\nu_1\theta$, where $\theta$ is the fraction of the surface covered and $\nu_1$ a constant. If atoms condense only on uncovered parts, the rate of condensation is $\alpha_0\mu(1-\theta)$, where $\alpha_0$ is constant, measuring the efficiency of condensation on a bare surface, and $\mu$ the rate of collision of incident atoms per unit area of surface, given by the kinetic theory :

$$\mu = (2\pi mkT)^{-\frac{1}{2}}p = 2{\cdot}653 \times 10^{19} p(MT)^{-\frac{1}{2}} \quad . \quad (1)$$

where $p$ = pressure in baryes, $k$ = Boltzmann's constant, $m$ is the mass of an atom, and $M$ the atomic weight of the gas. For steady states the rates of evaporation and condensation are equal, hence

$$\theta = \alpha_0\mu/(\nu_1 + \alpha_0\mu) = \alpha_0\tau\mu/(\sigma_1 + \alpha_0\tau\mu) \quad . \quad (2)$$

where $\tau = \sigma_1/\nu_1$ = average life of an adatom, $\sigma_1$ being the number of adatoms per unit area of saturated surface ($\theta = 1$). Equation (2) represents the observed adsorption on plane surfaces with reasonable accuracy in a surprisingly large number of cases.

The vapour pressure of a liquid is given over a wide range of temperature by

$$p = AT^{\gamma}e^{-b/T} \simeq A_0 e^{-b_0/T}. \quad . \quad . \quad (3)$$

Trouton's rule requires that $\gamma = 0$ and $A$ is a universal

constant; Hildebrand's rule that $\gamma = 1$ and $A$ a universal constant. A comparison with experimental data for liquids shows that Hildebrand's rule gives better results than Trouton's, but a rule which gives still better agreement is obtained by putting $\gamma = 1{\cdot}5$, when $\log A_{1{\cdot}5} = 6{\cdot}37$. The vapour pressures of solids, the vapours of which have rigid molecules, are also given by this equation with $\gamma = 1{\cdot}5$ and $\log A = 6{\cdot}9$, but much larger values of $A$ are obtained if the molecules possess internal degrees of freedom. It is therefore assumed that such molecules in the vapour phase may possess high internal mobility, as though liquid, whilst at lower temperatures they may become rigid, as though solid. Such effects probably do not exist with molecules of vapours of liquids. This part of the paper contains a detailed and valuable analysis of experimental data.

The ratio of the latent heat of fusion to the melting point has high values for large molecules such as stearic acid, increasing roughly in proportion to the number of atoms in the molecule, and in such cases a large part of the heat of fusion represents an internal heat of fusion of the molecules themselves, which in the solid are rigidly arranged within the lattice, so that the molecule itself is solid, but when the solid melts the molecule also melts.

In considering the evaporation of adsorbed atoms from an adsorbed film containing $\sigma$ atoms per unit area, the value of $\tau$, the average life of the adatom, being the same for all, the rate of evaporation (atoms cm.$^{-2}$ sec.$^{-1}$) is

$$\nu = \sigma/\tau = \sigma_1\theta/\tau.$$

From (3) in the form

$$p = A_{1{\cdot}5}T^{\frac{3}{2}}e^{-b/T}$$

where

$$b = b_0 - \frac{3}{2}T = \frac{\lambda}{k} - \frac{3}{2}T,$$

$\lambda$ being the latent heat of evaporation per atom, and (1) in which $\mu = \nu_1 = \sigma_1/\tau$, we find

$$\tau = (2\pi mk)^{\frac{1}{2}}(A_{1{\cdot}5}T)^{-1}\sigma_1 e^{-b/T},$$

in which it is shown that $A_{1{\cdot}5} \simeq 8 \times 10^6$, and hence

$$\nu = A_{1{\cdot}5}(2\pi mk)^{-\frac{1}{2}}\theta T e^{-b/T}, \quad . \quad . \quad (4)$$

an equation for the rate of evaporation of atoms or molecules from monatomic films on surfaces which is shown to agree reasonably well with experiment for thorium, oxygen, and cæsium films on tungsten. In (4) the forces of interaction between adatoms are taken into account by the value of $b$, and since $b$ is in general a function of $\theta$, the value of $\nu$ is not proportional to $\theta$ except at such low values of $\theta$ that $b$ is near the limiting value for $\theta = 0$.

Although the conditions in which adsorbed films more than one molecule thick can be formed are rather unusual, they are discussed. In general, adsorbed molecules on plane homogeneous solids are acted upon by strong forces originating from the underlying solid. The adsorbed molecules thus become polarised and repel one another as dipoles with forces proportional to $M^2r^{-4}$ ($M$ = dipole moment; $r$ = distance), and attractive forces predominate only when two kinds of adsorbed molecules are present which become polarised in opposite senses, as cæsium and oxygen on tungsten or salts on metals, such as mercurous sulphate on mercury. In some cases, however, the forces exerted between solid and adatom are small, as when hydrogen molecules or helium atoms strike a chemically saturated surface such as tungsten covered with adsorbed oxygen. In such cases the average life of the adatom is so small that it does not even reach thermal equilibrium with the solid, so that the accommodation coefficient is much less than unity (0·1 - 0·2).

The equation of state of the two-dimensional gas composing the adsorbed film may be found by the virial method with a repulsive force specified in terms of dipoles:

$$FA = RT + \tfrac{1}{2}\Sigma(rf).$$

A two-dimensional van der Waals equation, in which the long-range forces are now repulsive, takes the form

$$(F - a/A^2)(A - A_1) = RT,$$

in which $A$ is the area containing 1 gm. atom and $A_1$ in the ordinary derivation considering only first order effects is found to be only half the area actually covered by 1 gm. atom of adatoms. Experimental data for oil films at high surface concentrations show that $A_1$ corresponds with a close packed film in which the molecules cover the surface completely, and a new theoretical derivation for the case of a high concentration of adatoms confirms this.

The choice of a dipole repulsive force for the virial expression is justified by the experimental result that adsorption of alkali metal atoms occurs strongly only when the electron affinity of the adsorbent metal exceeds the ionising potential of the alkali metal. The positive charge on the adatoms causes a change in contact potential by as much as 3 volts and a corresponding increase in electron emission. It is then shown that it is possible to calculate the moments $M$ as functions of $\theta$. In the case of cæsium on tungsten, these vary from 16 debyes for $\theta = 0$ to 6 debyes for $\theta = 0{\cdot}9$. The electron and positive ion emission rates are then calculated and found to be in agreement with experiment. In the first case, the influence of electron spin is taken into account and Dushman's equation, derived from the Sackur-Tetrode relation, is somewhat modified, although probably within the limits of experimental error.

The results on the evaporation of cæsium films are very different from those predicted by the old formula (2), based on the assumption that there are no repulsions between adatoms, but the general results are in agreement with the new equations.

The effect of inhomogeneity of the adsorbing surface, first predicted by Langmuir and since studied experimentally and theoretically by H. S. Taylor and others, is then considered. The importance of the so-called 'active areas' in determining the catalytic properties of surfaces, even plane surfaces, is well known. It is shown, however, that the calculations lead to the result that the tungsten surface is essentially homogeneous, although they indicate that on about 0·5 per cent of the surface the cæsium atoms are much more firmly bound than the rest. The active spots probably consist of isolated elementary surfaces each capable of holding one adatom.

## University and Educational Intelligence

CAMBRIDGE.—The Busk studentship in aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 whilst flying an experimental aeroplane, has been awarded for the year 1932–33 to Mr. Herbert Brian Squire, of Balliol College, Oxford.

LONDON.—The Coal and Corn and Finance Committee of the Common Council of the Corporation of the City of London has recommended the grant of £100,000 towards the new central buildings of the University which are to be erected in Bloomsbury (see NATURE of July 9, p. 49). At Lord Macmillan's suggestion, the gift of the Corporation will be devoted

to the building of the Great Hall. The grant will be payable over a period of ten years, in annual sums of £10,000, commencing on March 25, 1933, and is conditional on the balance of the cost of the Hall being subscribed, and that the Hall shall be identified permanently and prominently with the Corporation. In a letter to the University, the Lord Mayor expressed the hope that the subscriptions towards the balance will help still further to identify the University with the City.

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The University of London has recently issued a prospectus of twelve courses of university extension lectures to be held during the session 1932–33 at various centres in London. The method adopted in such courses is to follow each lecture with a conversational class. Written work will be set, the submission of which will be optional, but regular attendance, etc., will entitle students to enter for an examination at the end of the course, in connexion with which certificates will be awarded by the University. The courses include the following: twenty-four lectures on "The Psychology of Everyday Life", by Prof. Cyril Burt, at Gresham College; ten lectures on "Religion and Science", by the Rev. S. C. Carpenter, at the Kingsway Hall; twenty-four lectures on "Problems of Society and Government", by Mr. A. Barratt Brown, at the Mary Ward Settlement. The first lecture of each course is free. Further information with regard to these courses of lectures can be obtained from the University Extension Registrar, University of London, South Kensington, London, S.W.7.

The ninety-first session of the School of Pharmacy of the Pharmaceutical Society of Great Britain will open on Oct. 5, when the inaugural sessional address will be delivered by Dr. C. W. Kimmins, formerly chief inspector in the Education Department of the London County Council.

The Royal Institute of Public Health has recently issued prospectuses of three courses of lectures and lecture-discussions to be held during the coming winter. The Harben lectures will be delivered on Oct. 10, 11, and 12, at 4 P.M., by Prof. Max Neisser, professor of bacteriology and hygiene at the University of Frankfurt-on-Main, on "Some New Investigations regarding Old Bacteriological Problems". A course of eight lectures, to be delivered by various lecturers, will be given on Wednesdays, commencing Oct. 19, on "Preventive Medicine: The Maintenance of Health and the Avoidance of Disease". Six lecture-discussions have also been arranged to take place on Thursdays, commencing Oct. 27, on "Mental Defectiveness as a Medico-Sociological Problem". All the lectures are free. Further information can be obtained from the Secretary, Royal Institute of Public Health, 23 Queen Square, London, W.C.1.

Erratum.—In Nature of Aug. 27, p. 321, in the title of the thesis for the degree of D.Sc. (Engineering) conferred on Mr. C. E. Larard, the word 'their' should read 'other'.

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## Calendar of Geographical Exploration

### Oct. 2, 1788.—Western Pacific Islands

Capt. John Hunter sailed to the Cape via the Cape Horn route. In 1789 he carried out surveys of parts of the coast of New South Wales and reached Norfolk Island, where his ship was wrecked. In March 1791 he sailed for Batavia and discovered the Stewart Isles and the Lord Howe Archipelago, the latter group being the Ontong Java named by Tasman. After passing the Admiralty group, Hunter discovered and named Phillip Island.

### Oct. 5, 1876.—Records of an Arctic Winter

The crew of a vessel built and fitted out by a Russian, Sidoroff, who was interested in arctic navigation, began life in winter quarters at the Briochov Islands in the Yenisei delta, lat. 70° 48′ N. Nummelin, who was in charge of the expedition, with four exiles, kept temperature records from day to day and Nordenskiöld records his results in his account of the voyage of the *Vega*. Nummelin's four companions died of scurvy, but three others later joined him. A relief party came from the south on May 11 and tried to dig the vessel from the snow and ice, but it was again buried by a snowstorm. In mid-June the ice began to melt and the waters rose so high that Nummelin, with five men and two dogs and a small stock of food and fuel, had to pass six days perched on the roof of a hut. Night and day the men poled away the blocks of ice which threatened to crush the hut; on June 25 the water subsided and they were able to climb down.

### Oct. 6, 1777.—The Orange River

R. J. Gordon and W. Paterson left Cape Town on a journey in which Gordon reached the Vaal. The two men afterwards made several journeys in different directions, which resulted in the survey of the lower course of the Orange River and in great additions to knowledge of the botany of the region. Paterson was particularly interested in natural history and obtained a valuable collection of South African plants.

### Oct. 7, 1844.—From East Coast to North in Australia

Dr. Ludwig Leichhardt started from the Condamine River and reached the Gulf of Carpentaria. Leichhardt's aim was to find a route from the east coast of Australia to the north; in this he was successful, reaching Port Victoria in September of the following year. His journey covered 3000 miles, opened up valuable country, and added much to the knowledge of the orography and drainage of the region through which he passed. Leichhardt met his death two years later in an attempt to cross Australia from east to west.

### Oct. 8, 1515.—Estuary of the Plate River

Juan Diaz de Solis sailed from the port of Lepe, reached the Bay of Rio de Janeiro on Jan. 1, 1516, and continuing southwards entered the great estuary of the Rio de la Plata. De Solis reached the north of the Parana River, but was there murdered by Guarani Indians. Sebastian Cabot explored the estuary in 1527 and ascended the Parana to the limit of navigation, the Agipe Falls. A Spanish expedition under Pedro de Mendoza landed in the estuary in 1535 and founded the city of Buenos Aires, but the hostility of the Indians caused the settlement to disappear. In 1541, Cabez de Vaca landed on the island of Sta. Catarina, reached the mainland, and by December 1541 arrived at the Iquassu, a tributary of the Parana, and thence took possession of the Parana for Spain. De Vaca rebuilt the port of Buenos Aires, and on a later expedition up the Paraguay reached the marshy country of Xarayes; he had previously explored the northern shores of the Gulf of Mexico (see Calendar for Aug. 10).

## Societies and Academies

CAPE TOWN

**Royal Society of South Africa**, June 15.—**D. Epstein**: The action of histamine on the respiratory passages. A method was described by which the effects of drugs on the isolated trachea and bronchi of small animals can be recorded with a magnification of about two hundred times. Using this method it was found that histamine produces powerful constriction of the trachea and bronchi of the guinea-pig, but has no effect on or relaxes these structures in the cat. As a result of other methods of investigation it was concluded that histamine produces obstruction of the air passages of the guinea-pig by a direct constrictor effect on the musculature of the trachea, bronchi, and probably bronchioles, while in the cat the respiratory obstruction seen with this drug is due to a constriction limited to the bronchioles alone. On the basis of these results, hypotheses have been put forward in an attempt to examine the respiratory reactions seen in anaphylaxis and asthma.—**H. A. Shapiro** and **H. Zwarenstein**: The effects of hypophysectomy and castration on serum calcium in *Xenopus lævis*. The finding of Charles that removal of both lobes of the pituitary leads to a significant drop in serum calcium is confirmed. Spontaneous partial atrophy of the ovaries in vlei females is found to be associated with a significant drop of 24 per cent. Castration of vlei females gives the same fall in serum calcium as double hypophysectomy, that is, about 40 per cent. This result can be detected as early as eleven weeks after the operation. In males a slight rise of 7·6 per cent, which is not significant, is observed after removal of both lobes. Castration leads to a significant drop of 14·6 per cent. It is probable that in females the drop after hypophysectomy is primarily due to ovarian atrophy.—**B. G. Shapiro** and **H. Zwarenstein**: The effect of injections of arginine and histidine on urinary creatinine. Injections of large doses of arginine or of histidine gives a 12-40 per cent increase in urinary creatinine. Alanine has no effect. After injection of Locke's solution as a control the creatinine excretion was unaffected.—**A. J. H. Goodwin**: Some developments in technique during the earlier stone age. It is suggested that the lower palæolithic of Europe presents only the beginning and the end of a single technical development, which is better represented as a complete series in Africa. Further developments are also suggested as being represented by the Mousterian and the Grand Pressigny techniques.

GENEVA

**Society of Physics and Natural History**, June 16.—**R. Wavre**: Newtonian potential and topology. The author raises the question under what conditions two families of bodies can create the same potential in a certain domain, and shows the importance of the topological distribution of the bodies investigated.—**F. Vasilesco** and **R. Wavre**: Simple examples of multiform harmonic functions. This note establishes that any homogeneous spherical cap produces a Newtonian potential which is an element of a multiform harmonic function. The latter allows an infinity of determinations which ramify round the frontier line of the cap. There is no other singularity of the function, except this: the period function admits a pole at the centre of the sphere.—**E. Friedheim**: The respiratory function of the pigment of *Bacillus violaceus*. The author's experiments lead to the conclusion that the pigment of the violet bacillus accelerates respiration by acting as a hydrogen acceptor. It is not yet proved that it acts as a perfect catalyst regenerated during a cyclic process.—**G. Tiercy**: A historical note. The hypothesis of continental translations. The author points out that the hypothesis of continental translations was formulated by Snider in 1858 and by Père Placot in 1668. Without disregarding the value of Wegener's work, M. Tiercy considers that it is inexact to describe the hypothesis in question as Wegener's hypothesis.

SYDNEY

**Linnean Society of New South Wales**, April 27.—**Mary E. Fuller**: The larvæ of the Australian sheep blowflies. The following species are described: *Calliphora stygia* Fabr., *C. fallax* Hardy, *C. augur* Fabr., *Lucilia sericata* Mg., *L. cuprina* Wied., *Chrysomyia micropogon* Bigot, *Ch. rufifacies* Macq., *Microcalliphora varipes* Macq., *Sarcophaga* sp., *Peronia rostrata* A.D., *Ophyra nigra* Macq. A key is included by which these species may be recognised in the larval stage.—**J. R. Malloch**: Notes on Australian Diptera. Notes on species of the genera *Calliphora* (of which three species are described as new) and *Onesia* are given. A key is given for the determination of males of species of *Calliphora* related to *C. stygia*.—**H. Womersley**: A preliminary account of the Protura of Australia. A classification of the order is given, followed by descriptions of the Australian species, which consist of four new species of *Acerentulus* and two of *Eosentomon*.—**J. Andrews**: Rainfall reliability in Australia. Rainfall reliability is principally concerned with the amount of rain which might be expected during any season and the degree of probability of obtaining it. These two aspects of reliability are discussed on the basis of annual figures and for the continent of Australia as a whole.—**F. A. Craft**: Geographical studies in the Blue Mountain Tableland. In the Blue Mountain Tableland settlement is almost confined to the main route passing westward from Sydney to the interior, along which towns and villages have grown since the building of the Western Railway. Some of these depend on the tourist traffic, whilst others support mining and industrial populations. The higher tablelands are barren, but the valleys of the Cox and lower Wollondilly Rivers are used for grazing, and restricted bottoms for agriculture.—**W. L. Waterhouse**: On the production in Australia of two new physiological forms of leaf rust of wheat, *Puccinia triticina*. As a result of inoculating plants of *Thalictrum flavum* and *T. dipterocarpon* with a mixture of germinating teleutospores of the forms of *Puccinia triticina* designated 'Australian 1' and 'Australian 2', æcidia were produced. Uredospore cultures from these showed that three physiological forms were present. One was the form 'Australia 1', but the other two have not been previously found. Details of their reactions were determined. These new forms originated on the alternate host plant, most probably as the result of hybridisation of the forms 'Australian 1' and 'Australian 2'.

VIENNA

**Academy of Sciences**, July 7.—**Richard Weiss** and **Alfred Abeles** (with Ernest Knapp): Condensation of αα′-diphenyl-ββ′-benzofuran with unsaturated compounds. (2) 1 : 4-Diphenylnaphthalene and its derivatives.—**Anton Kailan** and **Paula Ulicny**: Ester-formation in glycerol and ethyl alcohol. The unimolecular velocity constants ($k$) for the esterification of $n$-valeric, caproic, caprylic, and $i$-valeric acids at 25°, catalysed by $c$ molecules of hydrogen chloride per litre, in glycerol with a mean water content of $w$ mol. a litre, are represented by equations of the form $c/k = \alpha + \beta w + \gamma w^{3/2}$. For the esterification of $o$-, $m$-, and $p$-toluic acids by alcoholic hydrogen chloride, the velocity constants are represented by a more complicated

expression; comparison of the results with those given by benzoic acid shows that the methyl group introduced has the greatest retarding effect in the ortho- and the least in the meta-position.—**Ernst Beutel** and **Artur Kutzelnigg**: (1) The possibility of following the recrystallisation of silver by coloration with iron chloride.—(2) Properties of silver chloride films formed by the action of iron chloride on silver surfaces.—**Alexander Köhler** and **Hans Leitmeier**: Thermoluminescence in minerals. The luminescence of a large number of minerals heated to 250°-350° on an earthenware or asbestos plate has been examined. The results differ markedly in some respects from those of previous investigators, no luminescence being shown, for example, with sulphides, tinstone, etc.—**A. Schedler**: Magnetic declination in Austria, Bohemia, Moravia, and Silesia. The results of investigations on the earth's magnetism in Central Europe during recent years are used to obtain a general view of the distribution of magnetic declination throughout Austria and parts of Czechoslovakia.—**Wilhelm Kühnelt** and **Ekkehard Schmid**: Conditions of life at the snow line of the upper Alps.—**Friedrich Querner**: The paraplasmatic inclusions of liver cells in the fluorescence microscope, and the luminous material. When subjected to the action of ultra-violet light of wave-length 4000-3000 A., the liver cells of various vertebrates, including man, exhibit striking fluorescence.—**Adolf Müller** and **Paul Krauss**: (1) Synthesis of ε-amino-*n*-heptoic acid. This synthesis was realised by the reduction of the phenylhydrazone of ε-keto-*n*-heptoic acid.—(2) 2-Methylhexamethylenimine. The constitution of this compound is confirmed by (*a*) its synthesis from ε-amino-*n*-heptoic acid via the lactam, and (*b*) by oxidative scission of *N*-benzenesulphonyl-2-methylhexamethylenimine to the corresponding derivative of ε-amino-*n*-heptoic acid.—(3) The action of alkali on 6-bromo-*n*-hexylamine and on 7-bromo-*n*-heptylamine. With the bromohexylamine only a small proportion of the 7-membered cyclic hexamethylenimin is formed, and with the bromoheptylamine, the formation of an 8-membered ring is not detectable.—**Georg Koller**: Ramalic acid. It is shown that ramalic acid, reported by Hesse (1861) and Zopf (1897) as occurring in *Ramalina pollinaria*, does not exist.—**Otto Brunner**, **Hanns Hofer**, and **Rosa Stein**: Amyrins. (2) Products of dehydrogenation by selenium. Further proof that amyrins belong to the triterpenes is obtained.—**Karl Morsch**: Action of ammonia and amines on the esters of unsaturated acids. (2) The action of ammonia, methylamine, and diethylamine on ethyl cinnamate.—**Herbert Haberlandt**: Microscopic investigation of a Morogoro mineral in incident light.—**Elisabeth Rona**: Evaporation experiments with polonium.—**Adelina Deseyve**, **Gerhard Kirsch**, and **Fritz Rieder**: Disintegration of the atom by neutrons. Experiments with a number of elements by the scintillation method are described.—**Marietta Blau** and **Hertha Wambacher**: Attempts to reveal photographically protons liberated by neutrons. These attempts have not yet been successful.—**H. K. Barrenscheen**, **Wilhelm Filz**, **Karl Braun**, **Konrad Müller**, and **Sándor Láng**: Chemistry and physiology of the adenosintriphosphoric acids. A constitutional formula is given for the adenosintriphosphoric acid discovered by Lohmann and simultaneously by Fiske and Subbarow.—**Rudolf Wagner**: *Ardisiandra Wettsteinii* n. sp.—**Robert Kremann** and **Robert Baum**: The galvanic potentials and constitution of gold amalgams. Amalgams containing less than 75 per cent of gold show the mercury potential, and those with higher proportions of gold, the gold potential. Only those poor in mercury are, therefore, resistant; the resistance limit corresponds approximately with the compound $Au_3Hg$, for which Pabst found a hexagonal lattice structure.—**Franz Griengl** and **Robert Baum**: Galvanic potentials of ternary gold-tin-mercury alloys. The potential-concentration curves of the three binary systems and of a number of ternary mixtures show that, in the mercury phase, the compounds AuSn and $AuSn_2$ must be dissociated.—**Ludwig Lämmermayer (jun.)** and **Robert Kremann**: The position of gold in the potential series of the electrolysis of molten alloys. In its alloys with bismuth, antimony, and lead, gold migrates to the cathode, whereas in those with aluminium virtually no displacement of concentration occurs. In the potential series, gold probably stands near to silver.—**Robert Kremann**, **Max Pestemer**, and **Paula Bernstein**: Ultra-violet absorption by binary liquid mixtures. (1) The system chloroform-acetone. In these mixtures the maximum of the acetone absorption band is raised appreciably, whilst the chloroform band is only slightly displaced. A faint band, corresponding with the compound of the two solvents, also appears.—**A. Dadieu**, **K. W. F. Kohlrausch**, and **A. Pongratz**: Raman effect. (23) Raman spectrum of polysubstituted benzenes. Of the two benzene frequencies, $\Delta v = 1000$ and 1600, the former is absent from the Raman spectra of all chloro-substituted benzene derivatives except the monochloro-, *m*-dichloro-, and *s*-trichloro-compounds. This frequency hence belongs to a form of vibration at which the molecule pulsates and has, not hexagonal, but trigonal symmetry, and either has or can form nodes at the 1-, 3-, and 5-positions; such symmetry must be ascribed to benzoic itself. The frequency $\Delta v = 1600$ is continually displaced to lower values as the loading of the molecule with chlorine increases, and for $C_6Cl_6$ reaches the value 1510. In this case the vibration is such that the atoms move almost tangentially in the plane of the ring; this vibration must disappear in a five-membered ring, but reappear in naphthalene, assuming the symmetrical form for the latter.—**Hans Lieb** and **Miloš Mladenović**: α-Elemol and elemonic acid.—**O. Aluta**: Culture experiments with *Arabis hirsuta* (L.) Scopoli.—**Th. Pintner**: Structures in *Tetrarhyncus* heads.—**Herbert Schober**: A highly sensitive photometer.

WASHINGTON, D.C.

**National Academy of Sciences** (*Proc.*, **18**, 343-408, May 15).—**G. A. Lebedeff**: Interaction of ruffled and rounded genes of *Drosophila virilis*. The gene for the character ruffled is normally recessive; in presence of the dominant gene for rounded wings, ruffled becomes dominant, producing a new character, roofed, which shows both the original characters in modified form.—**M. Louise Schmuck** and **Chas. W. Metz**: The maturation divisions and fertilisation in eggs of *Sciara coprophila*, Lint. Sperms in this species receive more than the haploid number of chromosomes; elimination seems to occur during differentiation of soma from germ-line.—**Anne Marie Dubois**: Elimination of chromosomes during cleavage in the eggs of *Sciara* (Diptera).—**B. R. Nebel** and **Iris J. Trump**: Xenia and metaxenia in apples (2).—**Willem J. Luyten**: Notes on stellar statistics (5). On the use of the first Laplacean error curve.—**John S. Hall**: The application of photoelectric cells sensitive in the infra-red to stellar photometry. Cæsium oxide on silver photocells cooled with 'dry ice' was used. Cooling reduces the current passing when no visible radiation falls on the cell to the limits of sensitivity of the galvanometer used, stabilises the photo-current, and apparently raises the glow potential. In practice the photoelectric current is nearly proportional to the incident light intensity over the range of stellar

magnitudes extending from 3·0 to 6·5 and gives reproducible results.—**G. H. Dieke** and **G. B. Kistiakowsky**: The rotational structure of the ultra-violet absorption bands of formaldehyde. Photographs were taken in the third order of the 40-ft. spectrograph of the Loomis Laboratory, giving a dispersion of 0·4 A. per mm.—**P. S. Crowell**: The ciliation of the oviducts of reptiles. In two lizards examined, there is a tract of cilia in the albumen-secreting region of the oviduct which probably convey sperms up the oviduct.—**S. C. Lind** and **Charles Rosenblum**: The combination of carbon monoxide and oxygen under the influence of radon. Carbon dioxide promotes the reaction, but only about 14·5 per cent of the ionisation is chemically effective. The recoil atom effect and the inverse square of the diameter law were also examined.—**Ernst Cloos**: 'Feather joints' as indicators of the direction of movements on faults, thrusts, joints, and magmatic contacts. These local joints are so named because they are arranged like the barbs of a feather; they frequently appear along boundaries of moved blocks, etc., and their position and direction indicate the nature of the movements which have taken place. Circular impressions were made on wet clay placed on two iron plates resting side by side. On moving one plate, the impressions are deformed, indicating the axis of strain, and tension joints, shear joints, etc., are formed. Parallel effects are observed in the field, suggesting that such laboratory experiments are useful imitations of natural conditions.—**Charles N. Moore**: On certain criteria for Fourier constants of $L$ integrable functions.—**I. A. Barnett** and **David Nathan**: Sphere geometry and the conformal group in function space.—**J. H. Roberts**: Concerning uniordered spaces.—**J. Karamata**: Remarks on a theorem of D. V. Widder.

## Forthcoming Events

*MONDAY*, OCT. 3

ROYAL SOCIETY OF ARTS (Special Meeting).—Robert Howden: "The Elimination of Reflections from Glazed Pictures in Galleries", at 3 P.M.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group, jointly with the London Section) (Jubilee Memorial Lecture).—Dr. G. D. Bengough: "The Corrosion of Metals in Salt Solutions and Sea-Water", at 8 P.M.

*TUESDAY*, OCT. 4

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Autumn Special Meeting).—Dr. H. M. Vernon: "The Measurement, in Relation to Human Comfort, of the Radiation Produced by Various Heating Systems", at 6.45 P.M.

*WEDNESDAY*, OCT. 5

SOCIETY OF PUBLIC ANALYSTS (Joint Meeting with the Food Group of the Society of Chemical Industry, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1).—Discussion on "The Changes in Fruit on Storage", at 8 P.M.

*FRIDAY*, OCT. 7

PHYSICAL SOCIETY (at the Imperial College of Science and Technology, South Kensington).—Dr. J. W. French: "The Manufacture of Optical Glass", at 5 P.M.

## Official Publications Received

BRITISH

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1433: Corrosion Fatigue Test on Aluminium Crystal. By Dr. H. J. Grant and D. G. Sopwith. Pp. 30+12 plates. (London: H.M. Stationery Office.) 2*s*. 6*d*. net.

Board of Education. Rules 101 (revised May 1932): Arrangements and Conditions for the Award of National Certificates and Diplomas in Building to Students in Technical Schools and Colleges in England and Wales. Pp. 7. (London: H.M. Stationery Office.) 2*d*. net.

Dominion of Canada: National Research Council. Report No. 25: The Drying of Wheat (Second Report). By E. Stansfield and W. H. Cook. Pp. 104+2 plates. (Ottawa: F. A. Acland.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 5 (New Series), No. 7, July. Abstracts Nos. 1179-1351. Pp. 215-250. (London: H.M. Stationery Office.) 1*s*. net.

Geological Survey Department: Tanganyika Territory. Short Paper No. 10: The Kimberlite and Associated Occurrences of the Iramba Plateau. By Dr. E. O. Teale. Pp. ii+10. (Dar es Salaam: Government Printer.) 2*s*.

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Year ended March 31st, 1932. Pp. 18. (Bathurst: Government Printer.) 3*s*.

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