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The Cost of Education.

THERE has just been issued the Seventh Report of the Select Committee on National Expenditure, a document, including appendices, of twenty-three folio pages, sixteen of which are devoted to the expenditure on public education, a subject which receives caustic criticism. It would appear that the net cost of education for the year 1920–21 for all forms of education from the public elementary school to the university throughout the United Kingdom is estimated at the vast sum of 97,206,548*l.*, of which 60,081,831*l.* is derived from taxes and 37,124,717*l.* from rates. This figure is in striking contrast to that of less than ninety years ago, when the local authorities contributed nothing from the rates and the only grant from the Exchequer was one made for the first time in 1834 of 20,000*l.* in aid of school buildings and not of their maintenance. This was the measure of our indifference to the cause of public education, from which the nation has suffered irremediable loss; it enabled more progressive nations with a finer insight into things of real value to compete with us in all departments of civilised life and its varied activities, to our great disadvantage.

Undoubtedly in these strenuous times all possible economies in national and local expenditure ought sedulously to be promoted, but it would be a foolish, not to say a disastrous, policy to limit unduly the expenditure in the means and encouragement of public education, especially for the mass of the people. It is demonstrable that a large percentage of this mass is susceptible to the greatest advantages which can be offered to it of facilities for the highest available education that the country can give. The Education Act of 1918 and the zeal which prompted and sustained its promoters throughout the lengthy debates in Parliament is the subject of deprecation in the Report, chiefly on the ground of the large expense in which the nation would be involved in carrying out its provisions at the present difficult time. Surely it is forgotten that expenditure upon education, wisely directed, is, with this qualification, a truly productive effort which will repay the nation a hundredfold within a generation.

The strictures in which the Committee indulges indicate a lack of genuine sympathy with the vital claims of the people to the benefit of a longer continued means of education for their children. Their claims go much beyond the demand for the familiar "three R's"; they require that the best fruits of literature and science shall be brought within their reach. The Committee views with something like dismay "an enthusiasm for education" on the part of the Board of Education, to which Mr. Fisher replies that "a Board of Education which was not enthusiastic for the promotion of education would not deserve to exist." It makes suggestions having for their object the serious curtailment of expenditure under the Education Act of 1918; such, for example, as would involve the withholding of the proposed continuation schools, one of the most valuable features of the Act; the prolongation of the vicious half-time system which mainly prevails in the textile districts of East Lancashire and West Yorkshire; the stoppage of new developments in the building of schools, both elementary and secondary, in certain towns and rural areas—this last policy has already been largely adopted by the Board of Education during the last five years, having regard to the high prices of materials and of labour, yet, it must be admitted, to the detriment of educational progress—the limitation of means of medical treatment so vital to the welfare of the elementary-school child; and finally, among other important developments made possible by the Act, the curtailment of the means of higher education so essential to the progress and well-being of the nation—objects which are set forth so ably in the Report of the Adult Education Committee and by the Workers' Educational Association.

It must be acknowledged that since the conclusion of the war there has been a remarkable development in public opinion as to the importance and value of education. The demand for secondary education has increased enormously, and the claims for admission to technical colleges and universities have been almost too great for their resources in teaching staff and equipment. In the year 1913–14 the number of full-time university students in the British Isles was roughly 30,000, or about 6·5 per 10,000 of population. The figures available for the year 1918–19 show that the number of students had almost reached 40,000. The number of students per 10,000 of population had jumped to 8·6; almost one in every thousand was receiving university training.

There has been but slight consideration given in the Report of the Select Committee to the enormous rise in the cost of materials and equipment, especially in reference to the secondary schools and technical institutions, during and since the war, nor has sufficient weight been given to the necessary rise in the salaries of the teaching staff due to the increased cost of living. This item alone accounts for 21,000,000*l.* in the estimated expenditure. If the schools and the higher institutions of learning are to be staffed efficiently with well educated and trained men and women, adequate salaries and prospects, and an assured provision such as the Teachers (Superannuation) Act affords for the time when they are no longer capable of rendering effective service, must be offered.

Mr. Fisher in a recent interview shows conclusively with regard to the Report in question that there are adequate safeguards in respect of extravagant expenditure both on the part of the Board of Education and on that of the public represented by the ratepayer. The nation will be well advised to encourage by all the means in its power the desire which is so plainly manifest for a longer life in the schools and for the advantages of an efficient secondary and university education for those who are qualified to receive it. Now that the war is over we are entering upon a serious and strenuous time, when all the trained brain power at our command will be needed to meet the competition which we shall assuredly be called upon to face, and after all, as Mr. Fisher truly said in the interview before alluded to, "a nation which can afford to spend 400 millions a year upon drink and 100 millions upon tobacco is not quite at the end of its resources."

Territory and Bird Behaviour.

Territory in Bird Life. By H. Eliot Howard. Pp. xiii + 308. (London: John Murray, 1920.) Price 21*s.* net.

ON the publication of his "British Warblers" (1907–14) Mr. H. Eliot Howard took rank as a naturalist of marked ability, as an observer who could be trusted, and as an interpreter well trained in scientific method, fertile in suggestion, cautious in application, and, above all, insistent on the importance of keeping in close touch with the evidence afforded by patient and systematic field-work. A salient outcome of his monograph was a re-grouping of the phenomena presented by birds in their breeding haunts around a concept of "territory." He has now marshalled the evidence in favour of this hypothesis in a work which neither the biologist nor the comparative psychologist can afford to neglect.

To grasp Mr. Howard's root idea, we must recall the familiar routine of a bird's behaviour—and it is clearly with behaviour that observation must primarily deal. There is an orderly sequence the biological value or utility of which is centred in race-maintenance. Within this we can readily distinguish successive phases which are contributory to the routine as a whole. In the life of the wide-range migrant there is departure from the south, arrival in England, settling down in some part of the country, mating, sexual union, nest-building, incubation, feeding and rearing of offspring, and then departure from the breeding quarters to the south. All this is familiar enough. But closer observation discloses other facts. The males arrive in advance of the females; each male settles down in a restricted area within which some bush or tree is thenceforth his headquarters; the extent of this area is determined by the range of flight in oft-repeated excursions from the headquarters, and constitutes the "territory," which varies in size according to the species; the male bird is intolerant of any intruder into this territory, especially of a male of his species, fights him, and drives him out; he sings with maximum vigour at headquarters before any female is in evidence; this expression in song makes an attractive impression on some hen bird when she arrives in migration from the south; she becomes his mate, lives with him within the territory, and helps to drive out intruders. Mating is consummated, a nest built, and a brood reared within the territory, which affords, in the main, sustenance to the family; and in due season they depart. Now, of course, the sexual act may be regarded as the pivot on which the whole system of behaviour turns. But Mr. Howard contends that, to change the metaphor, the territory is the scene of the drama between arrival and departure; that the territory is secured and defended and the outburst of song in evidence before the females arrive; and that the size of the territory is such as to meet the requirements of the future. He holds, then, that the territory, if not the pivot in which the cycle of behaviour is centred, is the hook of biological utility on which it is hung.

Now, with regard to any routine of behaviour or phase therein, four questions arise: (1) In respect of the behaviour itself, is it unlearnt, or is it acquired in the course of individual experience? (2) Under what conditions of external stimulation does it come? (3) What is the good of it—its biological value? and (4) On what, in the constitution of the bird, does it depend? To the first three questions observational evidence affords the data for a reply. The answer to the last is in large measure a matter of inference.

As to the first, Mr. Howard is quite clear that, on the evidence, much of the behaviour involved in territorial routine is in form unlearnt. In so far as it is unlearnt, it is instinctive. This does not mean that the constituent details, as the matter incorporated in the behaviour as a whole, are purely instinctive. They are obviously in large measure learnt. Skill in their performance has been acquired. It means that the male bird in his first year occupies and protects the territory, and acts therein in specific ways, without having learnt by previous experience this *form* of behaviour-routine as a whole. Secondly, the external stimulation is, in Mr. Howard's opinion, afforded by the territorial situation, and not, in the early stage, by the presence of a female. To drive away an intruder involves, of course, the stimulus of his presence; it is, however, within the territory that the occupant attacks him; elsewhere, beyond its confines, the behaviour is no longer the same. The territory is, therefore, a feature of the situation that counts. Thirdly, it is clear enough, on the evidence, that the procedure has biological value. But—and this is of prime importance—Mr. Howard does not regard the prospective value of instinctive behaviour as implying the presence in mind of an end for the sake of which the bird acts. The biological value of securing a territory is the mating which follows in due course. *We* expect this outcome because we have knowledge of routine based on observation. But if the male in his first year has never mated, he cannot, on the basis of individually won experience, foresee this mating and what follows thereon. It is not for him an end to be attained by his behaviour. This is important—nay, essential—to the interpretation offered. For if there be inherited *knowledge*, the whole matter is easily explained as due to ancestral experience transmitted through "memory" to the bird that behaves under its guidance.

We come, then, to the fourth question: On what, in the constitution of the bird, does the behaviour depend? Mr. Howard refers to physiological changes in the organism which are correlated with tendencies to act in just that way which is open to observation in the unlearnt behaviour. This is what we speak of in a broad and general way as the nature of the bird. But this nature, and the correlated psychical nature, is different on different occasions. It is also attuned to the circumstances at the time, and gives to the behaviour much of its biological value. Such an attunement of the nature Mr. Howard calls a disposition. It is a state of physiological and psychical preparedness to act appropriately when the requisite stimulation is afforded. At the moment of action it is focussed as impulse. Thus at least may be interpreted many of Mr. Howard's statements, though in others there seems to be little difference between disposition and impulse. He often speaks of the disposition or the impulse as being "rendered susceptible to stimulation." For example, the territorial situation renders the impulse to drive away intruders susceptible. Some might prefer to speak of the susceptibility of *the bird* when it is in such a state as to respond to these or those external conditions. We thus avoid the risk of hypostatising a disposition or "an instinct." The essential point, however, is that the disposition that is inferred from the performance of unlearnt acts has factors which are congenital, and do not depend on individually won experience.

Brief illustration may here be given of changes of disposition. During the winter, before the mating season, lapwings live together in flocks. The males are seemingly on the most friendly terms with each other. Just such minor squabbles occur as may give some savour to the life of enjoyment. The females are, for the males, just other birds in the flock, and are not viewed, so to speak, in the light of a disposition to mate. Then in due season come the changes which constitute *ad hoc* physiological and psychical preparedness. Now one male and now another leaves the flock and occupies a territory in the fields; and, once there, he is intolerant of other males, fighting with any intruder for all he is worth. With the physiological change (partly due to specific internal secretions contributed to the blood-stream) there is a complete psychical change in the dispositional attunement of the bird's nature. Substantially the same presentation afforded by another male is now linked with quite different modes of overt behaviour. No longer gregarious, he is a solitary occupant of a restricted domain, driving all other males away. Presently he is joined by a mate, and the normal routine of reproduction runs its course. But if a cold snap should come on, the separated males may reunite in a flock, and the male is then no longer intolerant of other males. The physiological state probably reverts to its winter poise, and with this is correlated a reversion to the previous psychical disposition. But it seems that when a male bird (lapwing or other) has secured a territory and is intolerant therein of all others save a mate, he sometimes returns for a while to the flock which occupies a neutral area. *There* he is no longer intolerant of others, but moves among them on quite friendly terms. Hence in different circumstances, (1) in his territory and (2) in the flock, his disposition is different, so that occupancy of a territory appears to be a determining condition of the behaviour observed therein. If this sort of thing occurred in so marked a form in human life, it would perhaps be attributed to "dissociation," and described as an instance of double personality, two "streams of consciousness" being separated as if by a barrier. In any case, just thus, it seems, does the male bird in his first year behave, though he has never so behaved before, or seen others so behave.

Exigencies of space preclude more than an outline sketch of Mr. Howard's main thesis. The treatment in detail is admirable in its method of raising and meeting difficulties with no attempt to shirk them. The way in which the expression of song may produce a different impression on others at different times and in different circumstances is dealt with suggestively. All may not agree with Mr. Howard's conclusions; but all will admit the transparent candour of a genuine seeker after truth. One would like to comment on his contribution to the solution of the difficult problem of migration—turning upon the alternating interplay between the territorial and the gregarious poise in disposition. But lack of space forbids. The book is well written, well printed, and well illustrated, with photogravures from drawings by Mr. G. E. Lodge and Mr. H. Grönwold.

C. LL. M.

Airscrews in Design and Performance

Airscrews in Theory and Experiment. By A. Fage. Pp. ix+198+7 folding plates. (London: Constable and Co., Ltd., 1920.) Price 34s.

IT is difficult to place this book in the scheme of aeronautical progress, for it does not deal adequately with either the theory or the practice of airscrew design. The author has not succeeded in the idea expressed in the first sentence of his preface, where he says that "an endeavour has been made to present in this work an accurate and comprehensive account of the science of the airscrew from both its theoretical and experimental aspects." It is well known to all those connected with the experimental side of aeronautics that Mr. Fage, as a result of his position at the National Physical Laboratory, has had greater facilities for original work than any other British worker. The number of papers in his name which occur in the bibliography testifies to his activities, and the book cannot fail to have an importance in many directions. One would select chaps. v., vi., and vii.—that is, those dealing with experimental data—as justifying the writing of this book.

What is missed is the presentation of the results of research in a form which stimulates application to the workaday theories of the immediate future. Instead, one finds a very important recent development of theory compressed into one and a half pages of the book in such a way that, without prior knowledge, it conveys nothing to the reader. The basic theorem on which design rests comes from the conception that the several elements of an airscrew blade produce an airflow which is essentially of the same character as the flow round a wing. The application of this theory to aerial propellers is due to Drzewiecki and Lanchester, but after some little use and comparison with experiment it was found to be insufficiently accurate for design purposes. The necessary idea for a next approximation was obtained from a realisation of the fact that a wing is always moving into fresh air, whilst an airscrew blade moves into air disturbed by other blades and by the previous passages of the blade itself. The thrust of an airscrew, being produced by dynamic means, involves the throwing back of a mass of air per second the axial momentum of which is equal to the thrust. Owing to the continuity of the airflow, it might therefore be expected that disturbances due to other blade passages would take the form of an "inflow" of air into the airscrew blade. Experiment provides support for, and can be used to give quantitative values to, a theory based on this idea.

In discussions of marine propellers, Froude developed a theory in which half the final momentum of the slip stream was added in front of the propeller disc. Lanchester applied the idea to aerial screws, but, with his sense of the physical incompleteness of the theory, he did not accept "half" as anything more than an approximation. The Fage-Collins theory referred to on p. 19 is merely a theory which supposes that wing elements modified by the assumption of an inflow velocity can be made to agree with an experimental check by the choice of a certain constant closely related to Froude's half.

It is known that a second approximation so made is important, but it is also realised that every unknown quantity, such as the effect of the ends of the blades, their shape, and the changes in type of flow due to centrifugal action, are attributed to inflow. Wood and Glauert devised a scheme for the experimental determination of "inflow" without the above complications, and described their tests in the report referred to by Mr. Fage. It was pointed out that a logical extension of the aerofoil theory would be obtained by placing a succession of aerofoils behind each other in a wind channel so that some of them were working in the disturbed air of blades further into the wind. The relative positions of the blades to correspond with an airscrew were not found to be inconvenient for experiment, and, finally, after tests in a wind channel, a further approximation was made which brought theory nearer to the truth. The differences from the Fage-Collins theory are too great to be dismissed as unimportant, and show that there still remain further factors to be investigated.

This fundamental step in analysis of airscrew performance is the one dismissed by Mr. Fage in less than two pages of his book, and his closing remarks indicate the rather illogical contention that because other points still remain to be explained, the new experiments are of little use. This should surely not be the attitude of research workers at the National Physical Laboratory. It is to be hoped that it does not represent the views of the late Advisory Committee for Aeronautics, to which most of the items of work at the National Physical Laboratory were presented before publication.

This example has been taken at some length as typical of the book, which, on the theoretical side, is sketchy throughout. Perhaps one is tempted to be too critical of a work which largely records war activity. On the other hand, where are we to look for the progressive development of knowledge in aeronautics if such places as the National Physical Laboratory fail us? Is the new Aeronautical Research Committee still accumulating a great mass of undigested material, of which Mr. Fage's contribution is a part, or is it keeping its activities for advice on the general lines of experiment and research? One is not too hopeful that the incubus of the war is being thrown off any more completely by his employers than by the author of the book under notice.

Nomography.

A First Course in Nomography. By Dr. S. Brodetsky. (Bell's Mathematical Series. Advanced Section.) Pp. xii+135. (London: G. Bell and Sons, Ltd., 1920.) Price 10*s.* net.

THE subject of nomography may be shortly described as dealing with the graphic representation of formulæ. As developed by M. d'Ocagne, there has been an increasing interest taken in recent years in the application of its methods to facilitating calculation in engineering and scientific work generally.

In this "First Course," nomography is arbitrarily restricted to graphic representation in parallel co-ordinates, the resulting diagram being read by the collineation of points. It is true that there is a growing tendency to use the word "nomogram" for such a representation only; but, apart from nomenclature, there are grave disadvantages in this isolated treatment.

For a clear and intelligent appreciation of the subject it is a matter of great importance to keep in the forefront the *principle of duality,* the connection between graphic representation in Cartesian co-ordinates (the intersection diagram) and that in parallel co-ordinates (the alignment diagram), and the transformation of the one into the other.

Throughout the book the explanations are clear and the diagrams excellent, but the former appear occasionally to be unnecessarily diffuse. Nearly fifty pages out of a total of fewer than one hundred and fifty are mainly occupied with a minute description of nomograms for performing simple addition and subtraction, a purpose for which they are seldom practically used. Some introductory reference to them is certainly advisable, but all that is necessary might quite well have been given in a few pages and a couple of illustrations.

Some of the space so saved could with advantage have been devoted to a description of the direct-reading four-variable nomogram, which is a combination of two parallel scales and a network. To this no reference is made, but it is of great importance in practical work.

Diversity of notations is a continual source of irritation in such subjects, but, of course, is at times unavoidable. In the present case it seems a pity that M. d'Ocagne's later notation has not been accepted as standard and used wherever possible. By later notation is meant the one adopted in that writer's "Calcul Graphique et Nomographie" (1908). It is wonderfully concise, without any sacrifice of clarity or completeness, and is quite simple to grasp. M. d'Ocagne evidently considers it an improvement on the more cumbrous notation of his earlier "Traité de Nomographie" (1899), as he has continued to use it in his latest brochure, "Principes usuels de Nomographie avec application à divers problèmes concernant l'Artillerie et l'Aviation" (1920).

Metallurgy for Dental Surgeons.

A Manual on Dental Metallurgy. By Ernest A. Smith. Fourth edition. Pp. xvi+285. (London: J. and A. Churchill, 1920.) Price 12*s.* 6*d.* net.

SMITH'S "Dental Metallurgy" is read by so many dental students that the goodness or badness of the text has a considerable influence on the stage of knowledge of the embryo surgeon-dentist. Thus for many years it was impossible, even with the help of photomicrographs showing the two metals in patches like the stripes on a zebra, to convince the dental student that a eutectic was a mixure, because the author of this book had declared that such a patchwork might be a chemical compound! This error has, fortunately, been corrected in the new edition, which shows many useful improvements resulting from the incorporation of the rudiments of modern scientific metallurgy.

In spite of these improvements, the general tone of the book is still unsatisfactory, and carries with it the impression that the dental surgeon is content with a much lower standard of knowledge than are his medical colleagues. Thus, in view of the fact that for many years every candidate for the L.D.S. has had to pass an examination in elementary chemistry before taking the test in dental metallurgy, it is almost incredible that a standard text-book should attempt to teach metallurgy without making use of chemical equations. It is, nevertheless, true that the author has described the extraction of the metals from their ores (for which formulæ are usually given) without in any instance providing a chemical equation to express the action which takes place; it must therefore be taken as a singular compliment to the work on dental amalgams, carried out in the Laboratory of Physical Chemistry at Bristol a short time before the war, that it has provided the author with the only example of a chemical equation which the reviewer has been able to discover in the whole of the volume. This treatment of the subject can, however, scarcely be regarded as a compliment to the dental profession; and, even if it represented a reasonable point of view when the first edition appeared in 1898, the time has surely come when dental text-books should be addressed to readers with some knowledge of elementary science, instead of being lowered to the standard of a trade-class of mechanics or plumbers. T. M. L.

Our Bookshelf.

Peat Industry Reference Book. By F. T. Gissing. Pp. xxiv+292. (London: Charles Griffin and Co., Ltd., 1920.) Price 7*s.* 6*d.*

THE author, alone or in conjunction with Bjorling, has already published two books on peat. The present volume deals mainly with those developments in the peat industry which have arisen since the publication of the previous books. It is divided into eight sections, dealing with the formation of peat, its winning as cut peat, machine-formed peat and pressed peat, peat gas and its by-products, power gas, peat-moss litter, peat mull and other products, such as alcohol and paper obtainable from peat. The eighth, and last, section contains miscellaneous information, formulæ, and tables, which will be of much use to persons dealing with peat.

The various processes patented, or worked on an experimental scale, have been faithfully described from the point of view of the inventors or exploiters of these processes, and it is this circumstance which constitutes the chief defect of the book. Claims which are experimentally unjustifiable are occasionally admitted into the book without criticism, and for this reason some of the statements made are quite at variance with the actual facts, and are likely to mislead readers unacquainted with the properties of peat. Everyone knows, for instance, that a peat-pulping machine exerts practically no *cutting* action on peat, yet the claim that one peat-pulping machine *cuts the cells* of the peat fibres is passed without comment. Again, under another process it is stated that wet raw peat contains 20 per cent. of dry peat, and gives 8 per cent. of charcoal. As a matter of fact, wet raw peat from an undrained bog contains only about 8 per cent. of dry peat, and gives only about 2·8 per cent. of charcoal, and even from a well-drained bog the amount of charcoal got from 100 tons of the raw peat rarely exceeds 3·5 tons. It is evident, too, from this book that some "inventors" are still unable to grasp the elementary fact that in order to obtain 100 tons of dry peat from raw peat by the aid of artificial heating somewhat more than 100 tons of dry peat must be burnt to develop the heat required.

Text-book of Pastoral and Agricultural Botany: For the Study of the Injurious and Useful Plants of Country and Farm. By Prof. J. W. Harshberger. Pp. xiii + 294. (Philadelphia: P. Blakiston's Son and Co., 1920.) Price 2 dollars.

A KNOWLEDGE of the useful and poisonous plants on a farm is an essential part of the equipment of the agriculturist, but hitherto the requisite information has been to a large extent scattered and difficult of access. In the present volume the account of the stock-killing and poisonous American plants is thorough and comprehensive, a specially useful feature being the inclusion of methods of treatment where they are known. It is a pity that the photographs of affected animals are not reproduced more clearly, as several of them fail to illustrate their point.

The crop plants are dealt with sufficiently, though briefly, and the bibliography at the end of each chapter assists the student to follow up any requisite line of inquiry. It may be suggested that in future editions an "author index" would greatly enhance the value of the book, as at present it is not always easy to determine if a reference is included. The laboratory exercises which follow each chapter are very practical and well thought out, and render the book serviceable to the private worker, as well as to the class student. The same object is attained by the inclusion of a glossary with the detailed index. Prof. Harshberger is to be congratulated on the production of a much-needed working manual, the value of which lies not only in the well-arranged and clearly written information it contains, but also in the suggestiveness which renders it adaptable for use in countries other than America. W. E. BRENCHLEY.

This Wonderful Universe: A Little Book about Suns and Worlds, Moons and Meteors, Comets and Nebulae. By Agnes Giberne. New illustrated edition, completely re-written. Pp. x + 182. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) Price 6*s.* 6*d.* net.

MISS AGNES GIBERNE is well known for her charmingly written books on elementary astronomy. This is a new edition of an earlier work, carefully brought up to date, some excellent photographs of the moon, Mars, eclipses, and nebulæ being reproduced. The celestial phenomena are described in clear and vivid language, the difficulties likely to occur to a beginner being answered in anticipation. The book is made more interesting by the inclusion of a certain amount of legitimate speculation on the development of worlds and systems, and the probable condition of the different planets. The concluding section, "Immensity—and Man," deserves thoughtful study.

A few slips should be corrected. P. 69: One of our athletes would only jump 2·6 times as high on Mars as on Earth. "Over a good-sized house" is misleading. P. 84: The paragraph about TG misses the chief interest of the Trojan group of planets—the equilateral configuration with Sun and Jupiter. P. 108: Neptune's orbital speed should be 200 times that of an express train—not three times. P. 124: Two upright sticks a yard apart are not strictly parallel, since both point towards the earth's centre. P. 134: Sun's density is wrongly stated to be less than Saturn's. P. 138 (plate): Date of Mina Bronces eclipse was 1893—not 1889. A. C. D. CROMMELIN.

Practical Physiological Chemistry. By S. W. Cole. With an introduction by Prof. F. G. Hopkins. Sixth edition. Pp. xvi + 405. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1920.) Price 16*s.*

IN spite of the fact that a fifth edition of this valuable book was reviewed in NATURE of August 28, 1919, another edition has rapidly become necessary. The volume has been revised and enlarged, and several new methods have been introduced, of which the most important is a modification of McLean's method for the determination of blood sugar. Other additions include Van Slyke's method for the estimation of blood chlorides, and the soya bean method for the estimation of the urea in blood. Six editions of the book have now appeared in sixteen years; this should be a sufficient guarantee of the worth of the contents.

Coal. By J. H. Ronaldson. (Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire.) Pp. ix + 166. (London: John Murray, 1920.) Price 6*s.* net.

MUCH information relating to the coal deposits of the British Empire is recorded in this book. The geology of the deposits is described, and the statistics of production and reserves in various countries of the world are given. Apparently the most important coal resources of the world are in the northern hemisphere, particularly in countries near the Atlantic Ocean. Roughly three-quarters of the world's coal supplies are located in North America, principally in the United States, while the British Empire contains less than one-fifth of the known coal deposits of the world. The monograph concludes with a list of references to publications dealing with the coal resources of the Empire.

Science German Course. By G. W. Paget Moffatt. With a glossary by J. Bithell. Third edition (sixth impression). (Science Text-books.) Pp. xii + 270. (London: W. B. Clive: University Tutorial Press, Ltd., 1920.) Price 5*s.*

THE third edition of this book is not very different from the first, which was noticed in NATURE of November 21, 1907. All the extracts in Gothic type have been removed to the end of the book, and in place of the separate vocabularies a complete vocabulary of all the words occurring in the extracts for reading has been inserted.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Heredity and Acquired Characters.

(1) MOST biologists believe that the heritage travels down the germ-tract. (2) All biologists believe that in the germ-cell are none of the characters which the individual afterwards develops, but only potentialities for producing them in response to fitting nurture. (3) It follows necessarily that only potentialities are transmitted. (4) All that is transmitted is not produced (as characters of the individual), for fitting nurture may be lacking. (5) Therefore, inheritance and reproduction are not synonymous terms. (6) The individual can produce nothing but what was potential in the germ-cell, and nothing except in response to fitting nurture. (7) Necessarily, therefore, all characters are innate, acquired, germinal, somatic, and inheritable in exactly the same sense and degree. Given these facts and inferences, I asked biologists why they described some characters as "innate," "germinal," and "inheritable," and others as "acquired," "somatic," and "non-inheritable." I gave the example of the head and the scar, both ancient products of evolution. Why, when the child is like his parent both by nature and by nurture, is he said to inherit the head but not the scar? Why is the word "inherit" used as synonymous with "vary," its direct opposite, in the case of the scar? Really, I was asking for such definitions of biological terms as would accord with the current usage of them. As yet I have got none. I think I shall get none.

I may be wrong in thinking that biological terminology is vague, and sometimes even unmeaning, or I may be right. If I am wrong, surely some biologist can give the definitions I ask for. If I am right, the matter is of importance even as a mere question of words. A science cannot progress unless its workers have means of expressing themselves precisely and clearly. Other interpretative sciences—*e.g.* mathematics, physics, astronomy, and chemistry—have such means. It is noteworthy that they all possess in addition a body of established truth—truth which no one who knows the facts disputes. But biology can boast of scarcely an important interpretation (not even the theory of natural selection) which is accepted by everyone. As in religion and politics, its workers are divided into more or less hostile sects and sub-sects—Lamarckians, Darwinians, Neo-Darwinians, Mendelians, mutationists, Mendelo-mutationists, biometricians, and the like. I submit that much of this extreme, and apparently irreconcilable, divergency of opinion is due to confusion of thought consequent on confusion of language.

But beyond words, the matter is important. Biologists classify characters as "innate" and "acquired." Physiologists ignore this classification, and, assuming that all characters develop in response to nurture, endeavour to ascertain what forms of nurture evoke them. In other words, they classify characters according to the nurtures which cause them to develop—use, injury, this or that hormone, and the like. This classification is not merely different from the biological one; it is actually antagonistic; for, of course, if all characters equally arise in response to nurture, they must all equally take origin in germinal potentiality—must be equally innate and acquired. If biologists cannot justify their use of terms (supply valid definitions), it appears to me that they have no alternative but to accept the physiological classification. If that be done, I conceive that some such simple formula as "The sole antecedent of non-inheritance is variation. Apart from variations, like exactly begets like when parent and child develop under like conditions," will almost cover the field of discussion.

In reply to Dr. Ruggles Gates's letter in NATURE of December 2, p. 440, if we believe with Darwin in his theory of pangenesis that the parts of the child are derived from the similar parts of the parent (the child's head from the parent's head, etc.), the distinction between variations and modifications vanishes. Every modification is then a variation. We can distinguish only between germinal and somatic variations. If we believe that modifications in the germ's environment (the soma) may so impress the germ as to cause variations, then I think we are accepting what nobody questions, though I believe the importance of variations so caused has been greatly exaggerated. If we believe that changes in the soma tend to impress the germ-plasm in such a remarkable and unlikely way that the child reproduces in response to a different stimulus the character which the parent produced in response to the stimulus that Nature had fitted his race to respond to, then undoubtedly that child has varied from the parent. He is of a different nature; he has not inherited. I confess I do not see how Mendelians and mutationists *as such* are concerned in this discussion. They think that fluctuations are modifications, and that only mutations are true variations, and, therefore, that only the latter are inheritable—all of which is at least intelligible.

Prof. MacBride and Sir Ray Lankester (NATURE, December 16, pp. 500–1) may conveniently be answered together. But if, after reading what follows, Prof. MacBride will precisely indicate the "quibble" he writes of, I shall be much obliged. In reference to his last paragraph, if the child of a parent with an extra digit lacks that extra digit, or if he is relatively fair, then he has varied from the parent, has he not? Yet he has not departed from what is normal in the species. Prof. MacBride tortures a word which has now an established and perfectly clear meaning.

In 1911–12 I instanced a scar as a so-called "acquired character." Then, as now, Sir Ray Lankester quoted Lamarck in the original French. Lamarck wrote about the effects of use and disuse (not about the effects of injury). Therefore, *pace* Sir Ray Lankester, a scar is not an acquired character. Therefore, "if you, without any warrant, alter the established signification given by the Neo-Darwinian to the chief term in his statement, you can, of course, convert it into nonsense, and your proceeding is merely farcical." It is as if I had asked why kippers were called whales and Sir Ray Lankester had insisted that the term was restricted to red herrings. Fortunately, I am in good company. Did not Weismann himself cut off the tails of rats by way of demonstrating that acquired characters were not transmissible? If in my letter Sir Ray Lankester substitutes any use-acquirements he likes for "scar," his requirements will be met. In 1911–12 Sir Ray Lankester declared I was "doing harm." Influenced, doubtless, by the opinion of so great an authority, the Editor closed the correspondence. Thus was I crushed. The odd thing is that at the time I believed—as I do now—that I was fighting my critic's—or shall I say my contemner's—battles. We had travelled by different roads, but had reached, as far as I could judge, the same goal, and I was seeking to clear the ground. But more of this anon.

If the writings of Lamarck (notably the laws quoted by Sir Ray Lankester) and of those of his successors (*e.g.* Spencer, Romanes, Wallace, Weismann, and even Darwin) be examined, two assumptions will be found—never formally expressed, perhaps, but always apparent. On one hand, it is assumed that all characters develop in response to use. On the other, it is assumed that this development is never considerable. Both assumptions are monstrously wrong. Even in human beings many characters (*e.g.* hair, teeth, external ears, and external organs of generation) do not develop in the least in response to functional activity; on the other hand, in the higher animals, and especially in man, most characters develop from the infantile standard wholly, or almost wholly, in response to that stimulus. Physically and mentally man is the educable animal. He is immensely responsive to both use and disuse.

Low in the animal scale we find little or no evidence of development in response to functional activity. Apparently, even in an animal so high in the scale as a butterfly, use does not cause development nor disuse atrophy. In the egg use plays no part. We have no grounds for supposing that any structures grow during the caterpillar stage *because* they are used. In lack of functional activity the butterfly's structures develop vastly in the chrysalis. Afterwards functional activity does not cause them to grow. The evidence as regards mind is even clearer. In all its conscious phases this animal seems purely instinctive. It does not profit from experience, it does not learn, it is not educable. At any rate, if it develops at all in response to mental functional activity, it does so to a very small extent. Higher in the scale animals are born more and more helpless, but more and more capable of developing in response to use. Nature substitutes "acquired" for "innate" characters. That substitution marks the higher animal. Presently we find animals so capable of learning that mates are able to recognise one another, and also to recognise offspring. Thus family life arises, whereby offspring are afforded opportunity to develop in response to use. At last we reach man, who is born particularly helpless and immature, but enormously capable of growing through use, both in mind and in body. To this potentiality he owes all his adaptability, all his morality, religions, intelligence, knowledge, his whole intellectuality.

Now consider whether the problem of the "transmission of acquired characters" furnishes materials "for a legitimate inquiry." (1) The evolution of the power of developing in response to use is *the* feature of the rise of the higher animals. Steadily this potentiality increases at the expense of other potentialities. It may be argued, therefore, with some appearance of plausibility, that "innate characters" tend to be "transmitted" as "acquirements"; but the supposition that "acquirements" tend to become "innate" is, in the face of enormously massive evidence, ridiculous. (2) For thousands of generations the muscles of the boy have developed into those of the ordinary man in response to use, but no one has suggested that these "acquirements" tend to be "inherited"—to develop in the lack of use. But let one man (*e.g.* a blacksmith) display his human adaptability by developing his muscles by a little more use, and the Lamarckian immediately begins to wonder whether this last scrap of development is "transmissible." (3) Acquirements consequent on use and injury (made as Nature designed them to be made) are all useful. Transmitted, they would be less useful, or useless, or, more often, burdensome. For example, of what utility would scars be to an unwounded man, or the muscles of a blacksmith to his descendant the clerk? Lamarckians gravely argue, in effect, that after Nature has expended millions of generations in evolving a useful trait, this trait, directly it appears, tends to be converted into a useless trait. Here we have the oddest view of evolution conceivable.

To us as rational beings the evolution of the power of developing in response to use is immensely the most important phase of evolution. Of course, everyone is more or less aware of it. Thus parents know that it is necessary to train children, and even schoolboys know that men are more educable than dogs, dogs than cats, and so on. But it is remarkable how this tremendous truth has been ignored in scientific literature. If Lamarck and his supporters had realised it, would they have argued for the transmission of acquired characters? If Weismann and his followers had realised it, would they have condescended to argue against such transmission? Would any men have asked whether nature or nurture is the stronger? Would they have concluded that "nature is certainly five, and perhaps ten, times stronger than nurture"? What caused all this blindness to exceedingly obvious truth? Plainly, it was caused by the classification of characters as "innate" and "acquired." This led to the assumption that use-acquirements are of trivial magnitude, and so threw a veil over reality.

Men of science who study organic Nature—zoologists, botanists, palæontologists, anatomists, physiologists, bacteriologists, psychologists, and the like—are necessarily specialists and, unless they pass the boundaries of their particular studies, very narrow specialists. Biology supplies the connecting links. Every science is at first purely descriptive. Later, as the woof to the warp, interpretation is added. As Newton interpreted facts of astronomy, so Darwin accounted for the structures which zoologists, botanists, and palæontologists describe. Physiology is accounting for the facts of anatomy. It tells, among other things, of the influences in response to which structures develop. Pathology and bacteriology are accounting for the facts, that medical men have described, in terms of causation (nurture). But psychology is as yet, in very great measure, purely descriptive, and, even so, in a very limited field. Perception, conception, association, and the like have been described, but there are other and, for people who seek practical results, even more important characters—*e.g.* courage, cowardice, chivalry, meanness, energy, prejudice, and, above all, intelligence and stupidity. How do these traits, which in their sum constitute individual and national "character," develop? Do they arise in response to training (functional activity), or in response to influences (hormones and the like) largely beyond our present control?

Only biologists are able to settle these problems, for they alone are in a position to combine knowledge sufficiently deep and wide with relative freedom from blinding prejudice, religious and other. Presently, when, drawing on the vast stores of verifiable evidence which are available, they account indisputably for the various items of human character, science will come into its own. It will then have an indisputable title to control education and make it scientific in the sense that right means are adapted to achieve desired ends. It will raise issues far more burning and vital than even Darwin and Huxley raised. It will give a new reading to history. This is what I meant when I said I believed I was fighting Sir Ray Lankester's battle. But, obviously, the first step must be to achieve a right terminology, and so a valid classification of fundamental data. How, then, shall we classify characters—as "innate" and "acquired," or as responses to this or that form of nurture? This is what I meant by "clearing the field."

Of one thing I am very sure: that so long as the present classification is maintained biology will never be other than a tumbling-ground for whimsies—Lamarckian suppositions, questions as to whether nature or nurture is the stronger, and the like. When Darwin, the greatest figure that biology has produced, worked on lines of Lamarck's classification he went hopelessly wrong—as in his theory of pangenesis. His whole success was achieved when he studied, not differences between characters, but differences between individuals.

Prof. Poulton's letter in NATURE of December 23, p. 532, which I have seen since writing the above, is valuable for its line of thought and for its definitions. He begins by comparing *individuals*, and finds that their likenesses and differences are separable into those which are inherent (blastogenic) and those which are acquired (somatogenic). This is the firm ground which Darwin occupied in all his valid thinking. No one doubts the existence of these likenesses and differences, and most biologists believe that only those which are blastogenic tend to be inherited (perpetuated) by offspring. Thus chicks resemble each other innately in that they have heads and differ by acquirement as regards scars. Next, Prof. Poulton transfers the terms "inherent" and "acquired" from the likenesses and differences between individuals to the *characters* wherein they are alike or different. The head is called "inherent" and the scar "acquired." He is now comparing the characters of the same individual. This change, subtle yet vital, is precisely the cause of the chaos which prevails in biology. We are now in the morass in which Lamarck and Weismann floundered. We have departed altogether from Darwin's point of view. We have transferred the argument from the chestnut horse to the horse-chestnut. In what particular is the head more inherent and less acquired than the scar? Prof. Poulton writes: "Whenever change in the environment regularly produces appreciable change in an organism, such difference may be called an acquired character." Suppose I decide to work harder and so develop my muscles beyond the ordinary standard which they have already attained through use. In what respect is the addition more "acquired" than the ordinary development (which is usually termed "innate")? What would be the change in the environment?

I think I can give Prof. Poulton better definitions. Whenever the influence in response to which a character (*e.g.* a blacksmith's muscles, scars) develops is *glaringly* obvious, biologists call that character "acquired" and "somatogenic"; but whenever the influence is *not glaringly* obvious (*e.g.* ordinary muscles, head) that character is called "inherent" and "blastogenic." Whenever a biologist considers a character innate he reasons as if the soma and nurture had nothing to do with it. Whenever he considers it "acquired" he reasons as if the germ-plasm and nature had nothing to do with it. In all this he adheres strictly to ancient popular usage, and is not troubled by such recently discovered, recondite things as germ-plasms and germ-cells. He may talk about the latter unendingly, but they do not influence his thinking. Situated at the hub, whence radiate all sciences connected with life, biology, because of its unique classification of characters, has rendered not only itself, but also all these other studies relatively impotent—intellectually, socially, politically. It can use their data only to a minimal degree; and is not used by them at all.

G. ARCHDALL REID.
9 Victoria Road South, Southsea, Hants.

The British Committee for Aiding Men of Letters and Science in Russia.

WE have recently been able to get some direct communication from men of science and men of letters in North Russia. Their condition is one of great privation and limitation. They share in the consequences of the almost complete economic exhaustion of Russia; like most people in that country, they are ill-clad, underfed, and short of such physical essentials as make life tolerable.

Nevertheless, a certain amount of scientific research and some literary work still go on. The Bolsheviks were at first regardless, and even in some cases hostile, to these intellectual workers, but the Bolshevik Government has apparently come to realise something of the importance of scientific and literary work to the community, and the remnant—for deaths among them have been very numerous—of these people, the flower of the mental life of Russia, has now been gathered together into special rationing organisations which ensure at least the bare necessaries of life for them.

These organisations have their headquarters in two buildings known as the House of Science and the House of Literature and Art. Under the former we note such great names as those of Pavlov the physiologist and Nobel prizeman, Karpinsky the geologist, Borodin the botanist, Belopolsky the astronomer, Tagantzev the criminologist, Oldenburg the Orientalist and permanent secretary of the Petersburg Academy of Science, Koni, Bechterev, Latishev, Morozov, and many others familiar to the scientific world.

Several of these scientific men have been interviewed and affairs discussed with them, particularly as to whether anything could be done to help them. There were many matters in which it would be possible to assist them, but upon one in particular they laid stress. Their thought and work are greatly impeded by the fact that they have seen practically no European books or publications since the Revolution. This is an inconvenience amounting to real intellectual distress. In the hope that this condition may be relieved by an appeal to British scientific workers, Prof. Oldenburg formed a small committee and made a comprehensive list of books and publications needed by the intellectual community in Russia if it is to keep alive and abreast of the rest of the world.

It is, of course, necessary to be assured that any aid of this kind provided for literary and scientific men in Russia would reach its destination. The Bolshevik Government in Moscow, the Russian trade delegations in Reval and London, and our own authorities have therefore been consulted, and it would appear that there will be no obstacles to the transmission of this needed material to the House of Science and the House of Literature and Art. It can be got through by special facilities even under present conditions. Many of the publications named in Prof. Oldenburg's list will have to be bought, the costs of transmission will be considerable, and accordingly the undersigned have formed themselves into a small committee for the collection and administration of a fund for the supply of scientific and literary publications, and possibly, if the amount subscribed permits of it, of other necessities, to these Russian *savants* and men of letters.

We hope to work in close association with the Royal

Society and other leading learned societies in this matter. The British Science Guild has kindly granted the committee permission to use its address.

We appeal for subscriptions, and ask that cheques should be made out to the Treasurer, C. Hagberg Wright, LL.D., and sent to the British Committee for Aiding Men of Letters and Science in Russia, British Science Guild Offices, 6 John Street, Adelphi, London, W.C.2.

MONTAGU OF BEAULIEU,	BERNARD PARES,
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E. P. CATHCART,	C. S. SHERRINGTON,
A. S. EDDINGTON,	A. E. SHIPLEY,
I. GOLLANCZ,	H. G. WELLS,
R. A. GREGORY,	A. SMITH WOODWARD,
P. CHALMERS MITCHELL,	C. HAGBERG WRIGHT.

The Pea-Crab

(*Pinnotheres pisum*).

THERE is an apparent discrepancy between Dr. J. H. Orton's interesting description of the pea-crab in NATURE of December 23, p. 533, and that given by Dr. W. T. Calman, whom he quotes. Dr. Orton attributes the impunity with which the male crab and the male-like female sustain the nip of a bivalve to their "extraordinarily strong carapace" (p. 534). On the other hand, Dr. Calman, discussing whether the Pinnotherid crabs should be reckoned commensals or parasites, observes that they "show one of the characteristics of parasites in being to some extent degenerate in their structure. The carapace and the rest of the exo-skeleton, no longer needed for protection, have become soft and membranous" ("Life of the Crustacea," p. 217).

Does not Dr. Calman's suggestion tend to confound racial degeneracy (such as environment has imposed upon Crustacea and fishes inhabiting subterranean waters, or such as has been induced by habit of life on certain parasitic species of Hemiptera) with modification of growth and adaptation of functional activity in individuals approaching parturition? If the female crab does not, after moulting within the bivalve, renew the hard carapace which protected her in obtaining entrance, the diversion of nutriment to her swelling spermothecæ can scarcely be accounted degeneracy. Rather it suggests analogy to the extreme case of *Termes bellicosus*, the so-called white ant, which is neither parasitic nor, presumably, racially degenerate, but the queen-mother of which is perennially and unintermittently parturient, with the result that, according to Smeatham, her abdomen "grows to such an enormous size that an old queen will have it increased so as to be fifteen hundred or two thousand times the bulk of the rest of her body," and twenty or thirty times the bulk of one of her worker offspring.

Dr. Orton having carried research into the pea-crab's life-history a stage further than Dr. Calman, it is to be hoped that he will soon be able to announce a complete solution. HERBERT MAXWELL.

Monreith.

The Mechanics of Solidity.

IN connection with the correspondence on this subject in NATURE, attention may be directed to the attempts made by C. Benedicks (*Zeit. f. anorg. Chem.*, vol. xlvii., p. 455, 1905; *Ann. d. Physik*, vol. xlii., p. 153, 1913) to relate the hardness (H) to the other physical properties of the substance. He suggested that H is inversely proportional to the atomic volume (V) and to the coefficient of expansion (α), and therefore $HV\alpha$ is constant for different elements. This result includes the relation given by Mr. J. Innes (NATURE, November 18). Benedicks also proposed a new formula for the characteristic frequency (ν) of an element of atomic weight A in the solid state. He assumed that the frequency is proportional to $\sqrt{(H/A)}$, and hence to $\sqrt{(1/V\alpha A)}$. If the further assumption be made that the frequency so determined is identical with the frequency given by one or other of the formulæ summarised by Mr. V. T. Saunders (NATURE, December 23), other relations between the physical constants may be obtained. For example, according to the Sutherland-Lindemann formula ν is proportional to $\sqrt{(T_s/AV^{\frac{2}{3}})}$, where T_s is the melting point on the Absolute scale. Combining this with the previous result, we find $\alpha V^{\frac{1}{3}}T_s$=a constant, a relation given by Pictet in 1879.

I cannot altogether agree with Mr. Saunders (NATURE, December 23, p. 534) in his omission to consider the hardness in relation to other physical constants mentioned on the ground that it is a surface effect and not a bulk effect. Although the conditions at the surface differ from those in the interior of the solid, those conditions are determined by forces of the same general character in each case. In the case of a liquid a large number of relations between surface tension or intrinsic pressure and other physical and chemical constants have been given, and Laplace's theory points the way towards the co-ordination of these results. Reference may be made to the book by Willows and Hatschek on "Surface Tension and Surface Energy" (Churchill), in which this matter is discussed, and the conclusion that *solids* ought to possess surface tension and intrinsic pressure is emphasised. Mr. Saunders, if he is to be consistent, should omit reference to the melting point as well as to the hardness value, since a pure crystalline solid melts on the surface only, and the melting point is the temperature at which the solid can exist in equilibrium in contact with its own liquid under a specified pressure.

Mr. Saunders is no doubt correct in maintaining that further attempts to relate mechanical and other physical constants of solids must be based on modern theories of the structure of the atom.

H. S. ALLEN.

The University, Edinburgh.

The Meteorology of the Antarctic.

IN the preface to my book on Antarctic meteorology I wrote, "I was recalled to my work in India when the *Terra Nova* returned to the Antarctic in January, 1912," and the reviewer in NATURE of December 23 (p. 528) has very naturally concluded that this meant that I was recalled officially by the Government of India. It is, therefore, only fair that I should state the facts. I was granted three years' leave by the Government of India, which would have been sufficient if Capt. Scott's original plan of staying only one year in the Antarctic had been carried out. When, however, it was clear that the expedition would remain two years, I told Capt. Scott that I would stay the second year and write to India asking for my leave to be prolonged. When the *Terra Nova* arrived in January, 1912, she brought me a letter from Mr. Field telling me that Dr. Walker had gone to England seriously ill, and that he himself was so unwell that he did not see how he could carry on. In these circumstances I felt it was my duty to my colleagues in India to return at once.

I think most people will understand how in such circumstances I came to write that I was "recalled" to India, but it was an unfortunate expression, and would not have been used if I had realised the inference which would be drawn from it.

G. C. SIMPSON.

Meteorological Office, London, December 27.

The Mammals of South Africa.[1]

THE first two volumes of the work before us were noticed in NATURE of January 8, 1920, p. 469. We recommended them as containing a store of valuable information on the habits of the wild beasts. A vivid and often fascinating description of the species, with many excellent illustrations, made the perusal of these volumes a particular pleasure.

A study of the two volumes now before us justifies our recommendation. The illustrations are mostly good, while the text is clear and attractive. Technical terms have been avoided as much as possible, and in many cases the author gives us the origin and description of the Dutch terms by which the animals are generally known in South Africa.

No wonder South African farmers often lack that sympathy for the preservation of wild animals, and sometimes ruthlessly destroy everything that they fancy is harmful to agriculture. A number of species have already been exterminated, and are known only from old records and from a few specimens still scattered about in various museums. Of the interesting bluebuck, all that is left are five mounted examples, and, sadly enough, these are in foreign museums. Of the quagga there are, fortunately, a few representatives in our great collections. Yet an enlightened Government now protects species that seem to need protection. The bontebok, blesbok and springbuck, the noble kudu and eland, the African buffalo, and even the white rhinoceros and elephant, are carefully preserved in specially reserved areas.

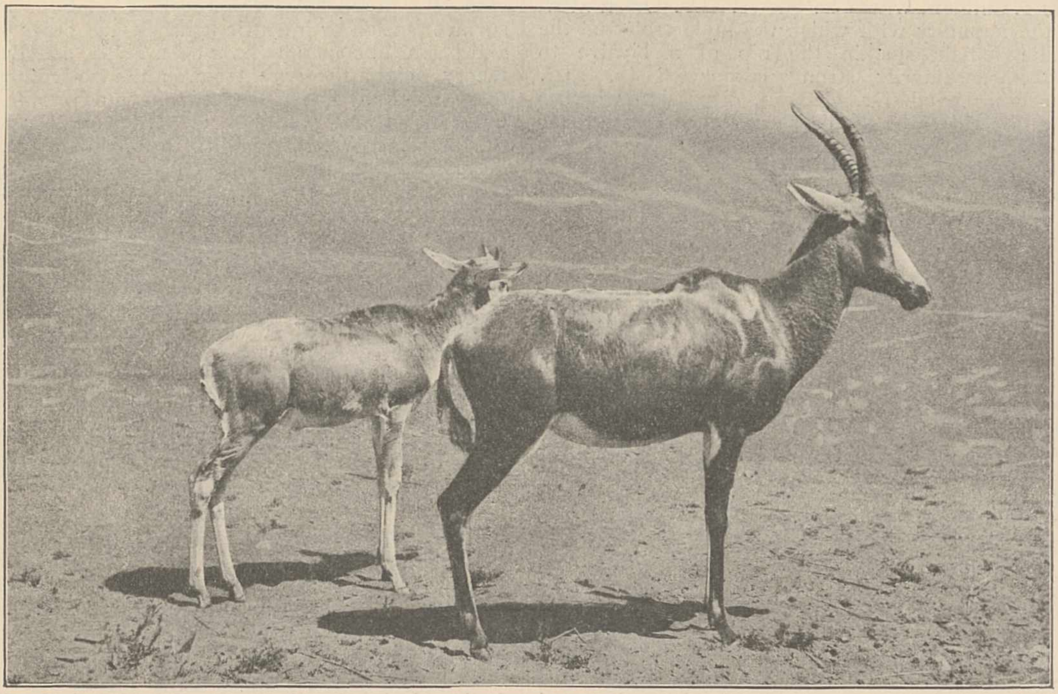

FIG. 1.—Blesbok. From "The Natural History of South Africa."

The prospective emigrant to that part of the world who may seek some enlightenment from these volumes will be struck by the extraordinary wealth and profusion of the fauna. What a paradise for the sportsman! From the farmer's point of view, however, the truly distressing prospect has to be faced of dealing not only with almost innumerable kinds of antelopes and other large game, but also with twenty-four different kinds of rats, including a giant rat attaining a length of 2 ft. without the tail; with wild pigs and hares; with many species of moles and other underground creatures; and with a voracious porcupine, all eager to obtain their share of the fruits of agriculture.

Reckless and indiscriminate slaughter in the past is no doubt partly responsible for the rarity and extinction of some of the larger game; but at times it became necessary for the farmer to take energetic measures for the protection of his crops. The stories of the vast herds of such antelopes as the springbuck remind us of the description of the American bison in the United States. At certain times the springbuck used to migrate in countless numbers into the fertile districts of South Africa. So prodigious were the numbers that the springbuck even choked the streets of the smaller villages. As late as 1892 a special issue of rifles was made to the Boers by the magistrate of the northern border of Cape Colony for the purpose of turning aside a threat-

[1] "The Natural History of South Africa." By F. W. Fitzsimons. "Mammals." In 4 vols. Vol. iii., pp. xiii+278; Vol. iv., pp. xix+271. London: Longmans, Green, and Co., 1920.) Price 12s. 6d. each vol.

ened invasion of migrating springbuck which would otherwise have utterly ruined the crops in the district (vol. iii., p. 92).

Man, however, is not altogether to blame for the scarcity of some of the larger animals of South Africa. Rinderpest undoubtedly played havoc among them, and large numbers of kudu, African buffalo, and others are known to have been decimated by this dread disease.

The smallest of the South African antelopes, about the size and weight of a large hare, is the blue duiker. It is wonderfully alert, and possesses the senses of sight, hearing, and scent in a high degree of perfection; so much so, indeed, that the bushbuck is believed to have made some sort of compact with it for their mutual protection (vol. iii., p. 42).

The fourth volume deals with the insectivores, rodents, whales and their kindred, and the edentates. One of the most interesting features of the South African fauna is the presence of the golden moles. Though very similar in habit to their European relations, the golden moles differ from them in structure and colour, and have been placed in a distinct family. It is worthy of note that an extinct relation of this isolated group (Necrolestes) has been discovered in the Santa Cruz deposits of Patagonia. The several curious burrowing rodents—viz. the blesmol, mole rat, and sand mole—are sometimes mistaken for true moles. They belong to quite a different order, and feed on roots, whereas the golden moles are insectivorous. The author's statement (vol. iv., p. 170) that two species of the octodont tribe of rodents inhabit South Africa requires some modification, for probably neither of these should be included in the family Octodontidæ. Right at the end of the fourth volume, instead of at the beginning of the work, the author explains what is meant by the term "mammals."

We have already commented on the author's charm of style, and throughout his work he makes one feel that he has acquired his extensive knowledge in the open field and has a personal and intimate acquaintance with most of the species he describes.

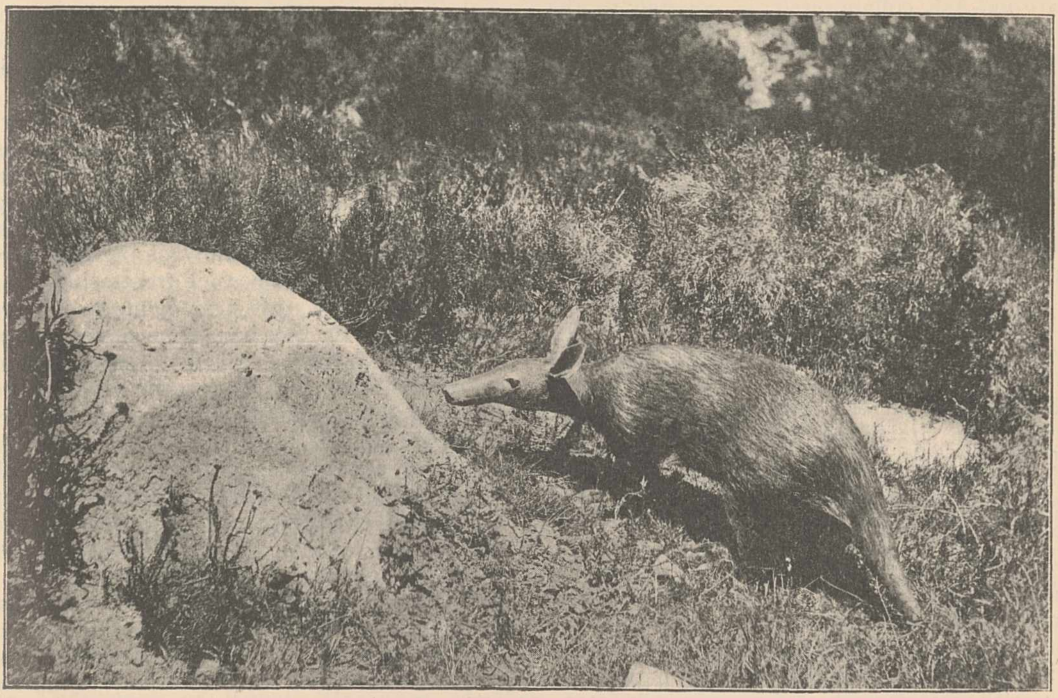

FIG. 2.—Aardvark. From "The Natural History of South Africa."

Science of Ventilation and Open-air Treatment.

DURING the war it was found that the physical condition of many of our young men was far from satisfactory, and there can be but little doubt that one of the contributory causes to this state of affairs was the ill-ventilated dwellings and factories in which such men frequently had to live and work, combined with a lack of opportunity or disinclination to take exercise. For example, in one region of England, of 200 youths of eighteen to twenty years of age examined and rejected, no fewer than eighty-five failed to pass on account of poor physique and other physical defects.

One important cause of defects of physique and of degeneration is the effect of occupation on workers. "One of the most striking features of the report of grading in the industrial districts is the rapid fall of the numbers of the young men who could be placed in Grade I. at the age of eighteen years compared to the numbers who could be placed in the same grade on being examined four or five years later" (Sir J. Galloway, *British Medical Journal*, September 11, 1920).

A second great cause of rejection was tuberculosis, much of which was unsuspected. Careful statistics from one city revealed the striking fact that of 277 cases proved to be tuberculous, 218, or 78 per cent., were previously unknown to the health authorities.

Such being the state of affairs, the publication of the second part of Dr. Leonard Hill's monograph[1] on the science of ventilation and open-air treatment is particularly to be welcomed. Containing much new work, the volume really comprises a series of essays reviewing the subject from various points of view, both theoretical and practical. The opening essay, in which Miss D. Hargood-Ash collaborated, is devoted to the physics of radiation, and presents the recent knowledge in regard to radio-active elements and the electrotonic theory. The final chapter deals with modern methods of ventilation and heating.

For several years past Dr. Hill, in conjunction with various colleagues, has been devoting his attention to this question. According to the popular notion, "stuffiness" and "closeness" of the air are due to an excess of carbon dioxide in the air, or to organic poisons from the breath. All recent work goes to prove the falsity of these old views. In regard to the latter hypothesis, all the positive results so far recorded as to the poisonous effects of the condensed moisture of the breath can be explained on the assumption that either the amount of condensed fluid injected into an animal was in itself sufficient to kill the animal by virtue of its comparatively great volume, or that the impurity arose from the protein of condensed saliva.

In regard to the carbon dioxide content of the air, much money has been spent in keeping the percentage of this gas down to the requirements of the authorities, yet up to 3 per cent. of carbon dioxide in the air breathed produces no unpleasant effects; with each breath it is a natural act to inspire the dead space air into the lungs, air which in itself contains about 3 to 4 per cent. of carbon dioxide. Indeed, the partial pressure of carbon dioxide in the alveolar air is the normal regulator of the respiratory act. Again, the ill-effects of "stuffiness" have nothing to do with smell; frequently those enduring the smell have no idea of its presence or potency.

It is now abundantly proved that the enervating effects of close and confined atmospheres are due to "heat stagnation" within the body. This is particularly liable to occur when the wet-bulb temperature is high, and efficient evaporation from the skin through sweating prevented. The discomfort under such conditions is alleviated by the use of fans which stir up the air. One of the most illustrative experiments in this direction is that in which a number of persons were confined in a hermetically sealed chamber in which a high wet-bulb temperature was induced by means of trays of water placed above electric heaters. At the height of discomfort to those inside, people outside the chamber could breathe the air without ill-effects. Circulation of the air by fans in the roof brought great relief to the occupants of the chamber.

The chemical purity of the air is important in so far as it may give an indication of infective bacterial content, and in certain trades in which the atmosphere becomes laden with dust particles, particularly silica dust. It is also important from the public point of view as regards the pollution of the air by excessive coal consumption. Coal consumption fouls the air with soot and smoke, producing fogs which diminish sunlight, thereby making cities dismal, and bringing loss of health and happiness to the town dweller. Herein the dweller in the country is at an advantage. Vital statistics show that, despite all the sanitary advances of recent years, the town dweller is still at a disadvantage as compared with the countryman, who frequently lives in any but hygienic surroundings. The country dweller owes his relatively robust health to many of the factors which make for success in open-air treatment.

The success of this treatment in tuberculosis depends upon its judicious application. Exposure to moving air induces efficient respiration, exalts the metabolism, and lowers the fever. It must be so employed that the bodily functions are not depressed and the heat-regulating capacity of the individual exceeded. The patient must always be happy and comfortable. As Dr. Hill puts it: "The ideal conditions out of doors are seen to promote the feeling of comfort and happiness, a gentle cooling breeze to promote adequate cooling of the skin and stimulate the metabolism of the body, coolness and low-vapour tension of the air to promote the evaporation of water from, and blood-flow through, the respiratory membrane."

The clothing of the body, in both health and disease, should always be directed to the prevention of heat stagnation. Many people greatly overclothe. Clothes should be as light as possible, permeable to air, allow free evaporation, and not become wet with water vapour in such a way that they cling to the skin and cause undue heat loss and a feeling of "chilliness." Permeability is essentially a matter of the method of weaving. The cellular type of weaving is to be recommended on this account for underclothing; for outer clothing close-meshed fabric is also to be avoided. Wool owes its advantage in underclothing to the fact that the elasticity of the hair keeps the garment off the skin, thereby securing an air layer beneath, which facilitates evaporation and prevents clinging wetness. The less the adherence, the greater the volume of entangled air, and the greater the heat-

[1] Privy Council. Medical Research Council. "The Science of Ventilation and Open-air Treatment." Part ii. Special Report Series, No. 52. Pp. 295. (London: H.M. Stationery Office, 1920). Price 6s. net.

retaining power, even of the wet material. In tropical climates there is particularly a great disadvantage in clothes which lessen evaporation. Heat-stroke is due to excessive heat stagnation.

In regard to indoor conditions, these should approximate as near as possible to the outdoor conditions of an ideal day.

Successful ventilation not only prevents heat stagnation of the body, but also keeps the temperature such that it stimulates the worker without producing uncomfortable cooling of the body.

In the British climate, of mist and cloud, radiant heat is always preferable to convected heat, hence the superiority of the open fire and the modern gas-stove. Radiant heat makes up for the absence of sunlight. Buildings should always, so far as possible, be warmed in such a manner as to keep the feet warm and the head cool. The judicious employment of fans to impart air movement will frequently make all the difference between good and bad ventilation. Dr. Hill's kata-thermometers prove of the greatest service in investigating the ventilation conditions of any building, and it is certain that they must be extensively employed in future to ensure satisfactory conditions, particularly in large buildings.

The question of the bodily heat regulation in the tropics is one of vital importance to the colonising white man. For years past there has been discussion as to whether it is possible for the white man to adapt himself efficiently to tropical climates, or whether this can be done only by pigmented races. Many authorities have inclined to the latter view.

The effect of the tropics is largely due to the action of the sun's visual rays, particularly those of the blue end, which, if sufficiently powerful and prolonged in action, have a lethal effect upon protoplasm. The ultra-violet rays are filtered out by the horny layer of the epidermis. The scales of the skin reflect diffusively many of the visual rays, particularly when the skin is wet with sweat. The function of pigment is to absorb the visual rays, thereby protecting the blood and living tissues from dangerous effects. The pigmented man can, therefore, have a thinner horny layer to his skin, and lose heat well through flushed blood-vessels, without risks of injurious effects from ground glare and sky shine. The view which attributes a higher heat-emissive power to the skin of the negro is erroneous. Despite the above advantages, however, pigment puts an extra tax on the heat-regulating mechanism of the body, since it has to get rid of the heat into which light rays are converted.

The great value of pigment is that it protects man from sunburn, and enables him to go naked and secure the full cooling power of the environment by losing heat by radiation, convection, and evaporation. The white man wears clothes to protect himself from sunburn, and the ill-effects of tropical climates are largely due to the wearing of unsuitable clothing, frequently from custom or from an idea of caste distinction. The white man also usually indulges in an unsuitable diet, which sets his heat production at too high a level. For this reason it is imperative that the white man in the tropics shall be suitably clothed and adjust his diet to the climate, resting during the hot hours, and taking exercise freely during the cool of the day.

The efficiency of the yellow races in hot climates shows that climatic adaptation to the tropics does not depend solely on pigmentation of the skin. As shown above, such adaptation seems to depend upon the correct correlation between the metabolism and the heat-losing mechanism of the body. Given proper sanitary measures against infectious disease, much can be done to promote the efficiency of the white race in hot climates by getting rid of the stagnant moist environment produced by clothes and houses. These in particular tell at present against the health of white women.

M. F.

The Discovery of Fossil Remains of Man in Java, Australia, and South Africa.

By PROF. A. KEITH, F.R.S.

PROF. EUGENE DUBOIS, the discoverer of Pithecanthropus, has recently published[1] an account of fossil remains of man found in a deposit in Java, which he regards as of Pleistocene age. In 1890, the year before he made his first find of the remains of Pithecanthropus at Trinil, Prof. Dubois was led to search for traces of ancient man in the district of Wadjak, which lies some sixty miles to the south-east of the site where his more famous discovery was made. His attention had been directed to the Wadjak district by the discovery there of a fossilised human skull in 1889. Further excavations of the terrace-like deposit in which the first skull had been found placed Prof. Dubois in possession of fragments of the jaws and cranium of a second individual, which were in the same state of mineralisation as the skull which first came to light.

Prof. Dubois has only now published a full account of these discoveries, made thirty years ago. He finds that the remains unearthed at Wadjak indicate that Java was at one time inhabited by a people very like the blacks of Australia, but in some respects even more primitive than they. The publication of an account of a fossil human skull found at Talgai, Queensland, by Dr. Stewart A. Smith[2] in 1918 has apparently induced Prof. Dubois to reinvestigate the fossil remains from Wadjak, and to compare them with the ancient Talgai skull. Thus for the first time it is possible for anthropologists to compare

[1] "De Proto-Australische fossiele Mensch van Wadjak (Java)," *Kon. Akad. van Wetensch. te Amsterdam Afdeeling*, May 29, 1920.

[2] Phil. Trans., 1918, ser. B, vol. ccviii., p. 351

the ancient inhabitants of Java and Queensland. The discovery in 1913 of fossilised human remains at Boskop, in the Potchefstroom district of the Transvaal, throws a welcome light on the ancient inhabitants of South Africa, and gives the means of comparing the early inhabitants of remote continents. An account of the Boskop find was contributed to NATURE for August 5, 1915, vol. xcv., p. 615, by Mr. F. W. FitzSimons, of Port Elizabeth Museum, and a detailed description of the remains has since been published by Mr. S. H. Haughton.[3] In none of these discoveries, in Java, in Queensland, or in South Africa, has it been possible to give a definite geological age to the deposits in which the human remains occurred, yet in each case a Pleistocene date has been assigned to the remains by their describers—an inference which is justified, not only by their condition and surroundings, but also by the primitive structural features which are stamped on them.

The more complete fossil skull described by Prof. Dubois is that of a woman showing features which characterise Australoid races, save that the dimensions of the skull are excessive. The length of this ancient woman's skull is 200 mm. and its width 145 mm., measurements which are rarely met with even in the most robust Australian male aborigines. Prof. Dubois, allowing for the great thickness of the cranial wall—10 mm. on the vault—estimates that its cranial capacity or brain space was 1550 c.c.—more than 200 c.c. above that of the average modern Englishwoman. The jaws of the second individual found are much larger and more robustly framed than those of the woman, and are inferred by Prof. Dubois to represent the opposite sex. The upper jaw and palate of this ancient man of Java are such as have never been seen before in either ancient or modern man. In anthropoid apes the molar teeth are set in two approximately parallel rows on each side of the palate; this arrangement is more exactly preserved in the extinct natives of Tasmania, and to a less degree in the native tribes of Australia, than amongst any other existing race of mankind. But in the Java or Wadjak skulls, although Australoid in all their cranial and facial features, the teeth are set on the palate in a horse-shoe form, much as is the case in the Pleistocene European—*Homo neanderthalensis*. The teeth, however, show none of the dental characteristics of that race. The width of the palatal area of the Wadjak fossil man, measured between the outer borders of the second molar teeth, is 81 mm., 7 mm. more than has yet been observed in any human palate. The length of the palate—measured from the crowns of the incisors to a line joining the hinder borders of the last molar teeth—must have been well above 60 mm.—a measurement occasionally exceeded in the palates of modern Australian natives. The palatal area, enclosed within the outer border of the dental arch, is enormous, being, according to Prof. Dubois' estimate, 41·4 sq. cm., to which some 4 sq. cm. must be added on account of the missing incisor crowns. The corresponding area of the average modern Englishman is 26 sq. cm.; the largest measurement in living native races is 36·7 sq. cm. These figures give some indication of the remarkable jaw and face development of the fossil Wadjak race.

The Talgai skull from Queensland, described by Dr. S. A. Smith, of Sydney University, is that of a lad of about fifteen or sixteen years of age. Its cranial walls had been severely crushed by earth-pressure, but fortunately the palate and face are in good condition—a most fortunate circumstance, for it becomes more and more evident that we must trust to facial rather than to cranial features for the recognition and discrimination of human races. So far as the cranial features and dimensions of the Talgai lad are preserved, they show Australoid characteristics—the cranial capacity being certainly above that of Australian aboriginal youths of the present day. Here, again, the outstanding character of the fossil type is to be found in the palate, which has been very fully investigated and described by Dr. S. A. Smith. In the form of its dental arcade the Talgai skull possesses the most anthropoid palate yet discovered. Very probably, were the palate of Piltdown man to be found, it would show these anthropoid features to an even greater degree. The two canine teeth in the Talgai boy are set very widely apart, almost as widely as the molar teeth. The width of the palatal area is 66·5 mm.; allowing for the unerupted wisdom teeth, its length amounts to about 70 mm.; the total area, although less than on the Javanese fossil Australoid skull, is still very large, amounting to about 40 sq. cm.

Thus we have evidence which seems to justify us in supposing that at a certain period of the Pleistocene age men fashioned in a primitive Australoid mould, with large brains and massive palates, lived in Java and Australia; but so far as the palate is concerned the fossil stock of Java had differentiated in one direction, the Australian in another. It is amongst the extinct race, which inhabited Tasmania down to modern times, that we find the nearest approach to the anthropoidal palate and the massive teeth of the Talgai boy. On a consideration of all his features we must place the Talgai boy in the ancestral stock of the Tasmanian type of Australoids. Dr. S. A. Smith cites the discovery of the fossil bones of the dingo in Australian deposits of Pleistocene date as evidence of the early arrival of man in the continent of Australia, for it is difficult to believe that the native dog arrived save in the company of man. The discoveries made at Talgai, in Queensland, and at Wadjak, in Java, lend strong support to this early arrival of man in Australia. Whether the Talgai lad represents the first invaders, and whether these early comers were the primitive ancestors of the aborigines of Tasmania, are doubts which must be settled by future discoveries.

[3] Trans. Roy. Soc. South Africa, 1917, vol. vi., p. 1.

In strange contrast to these ancient inhabitants of Java and Queensland is the ancient type of South Africa represented by the Boskop man. The characters of his skull are so peculiar that we must regard him as a separate and hitherto unknown type. As to his facial characters we know little; his eyebrow ridges and forehead show certain features which give grounds for the belief that the face was flattened—much as in living representatives of the Hottentot and Bushman stocks. From the fragmentary lower jaw one infers that the teeth and palate were of very moderate dimensions—not much larger, if any, than in modern Europeans. The dimensions of the cranial cavity, on the other hand, are enormous: the length of the cranium is 205 mm.; its width 154 mm.; and its capacity or brain space is estimated by Mr. Haughton to be 1832 c.c.—about 350 c.c. above the average for Englishmen. The vault of the skull is thick and flat, two great parietal bosses of bone rising up on each side of its median suture and marking the sites of the parietal eminences. There are also peculiar features in the region of the mastoid process behind the ear and in the zygomatic-temporal region in front of it. The only fossil skull which shows any marked degree of resemblance to the Boskop specimen is the Olmo skull found in a Pleistocene deposit in the north of Italy in 1863. It, too, is a very wide and long skull, with flat roof and projecting upper forehead, but showing none of the peculiar features of the Boskop skull. Mr. Haughton has rightly recognised that certain traits which are found in the Hottentot and Bushman skulls, as well as in the Boskop cranium, can best be explained by supposing the Boskop man to stand in the Pleistocene ancestry of those puzzling Mongolian negroids of South Africa—the Hottentots and Bushmen. Further, on the strength of the evidence referred to in the foregoing, we find, at a remote period in South Africa and in Australia, primitive representatives of the native races now occupying these countries; differentiation from the primitive to the modern type seems to have taken place *in situ* in each case.

Obituary.

THE death occurred on Thursday, December 23, of MR. FRANK PULLINGER, C.B., Chief Inspector of the Technological Branch of the Board of Education. Mr. Pullinger, who was born in 1866, was educated at Manchester Grammar School, Owens College, Manchester, and Corpus Christi College, Oxford. He took a First Class in the Final Honours School of Natural Science in 1887, and in 1889 was elected Burdett Coutts scholar of the University. After spending a year in research work at Oxford and another year as a University extension lecturer, he was in 1891 appointed Secretary for Education to the Devonshire County Council. This post he relinquished in 1894 in order to take up an appointment as an Inspector of Schools under the Science and Art Department. In 1900 Mr. Pullinger was appointed Divisional Inspector and in 1908 Chief Inspector of the Technological Branch of the Board of Education, into which the Science and Art Department had been merged. He was a man of great force of character and possessed a very intimate knowledge of the needs of technical education. The years during which he was Chief Inspector witnessed a rapid growth in the responsibilities of the Board towards technical education, and Mr. Pullinger's wide experience and close association with technical problems were in consequence of very great value. In particular it may be said that he organised an inspectorate containing in its ranks men of expert knowledge in engineering, building, chemical, and other industries, and transformed the whole process of inspection. His death at a comparatively early age is greatly regretted by all who have the future of technical education at heart.

THE death is announced on Christmas Day of the REV. HENRY HOYTE WINWOOD, of Bath, at the age of ninety years. Mr. Winwood was for half a century one of the most active amateur geologists in the West of England, and the stimulating friend of many who have made important advances in geological science. In early life he was associated with Prof. (now Sir) W. Boyd Dawkins and the late Mr. W. A. Sanford in several explorations of bone-caves and prehistoric burial places. In 1865 he announced the discovery of flint implements in definite association with the remains of extinct animals in the cave named Hoyle's Mouth, near Tenby. In his own district he diligently observed all temporary excavations, and made notes which were published in the Proceedings of the Bath Natural History Club. When the British Association visited Bath in 1888 he wrote the section on geology for the local handbook. He also took much interest in the Bath Royal Institution, and collected the fund by which it secured the unique museum of local fossils of the late Charles Moore. He delighted in making this museum accessible for the promotion of research. Mr. Winwood was elected a fellow of the Geological Society in 1864, served for many years on the council, and was a vice-president in 1898–1900 and 1915–17.

THE death of MR. J. G. V. MAIR-RUMLEY on December 20, in his seventy-eighth year, is announced. Mr. Mair-Rumley was a member of the Institutions of Civil Engineers and Mechanical Engineers, and gave much assistance to the research committees inaugurated by the latter institution. His papers contributed to the Institution of Civil Engineers were awarded the Watt medal and a Telford premium in 1881, and a Telford premium in 1885.

Notes.

THE New Year Honours Lists which were issued at the end of last week include five barons, five Privy Councillors, twenty-one baronets, sixty-nine knights, and two Companions of Honour. Among the honours we note in particular the following conferred upon men whose names are known in scientific fields:—*Privy Councillor:* The Rev. Dr. Thomas Hamilton, for service to the cause of education in Ireland, first as President of Queen's College, Belfast, and afterwards as President and Vice-Chancellor of the Queen's University of Belfast. *Knights:* Prof. P. R. Scott Lang, for more than forty years Regius professor of mathematics in the University of St. Andrews; Mr. P. J. Michelli, secretary to the London School of Tropical Medicine; Dr. S. S. Sprigge, editor of the *Lancet*; Prof. James Walker, professor of chemistry, University of Edinburgh; and Dr. Dawson Williams, editor of the *British Medical Journal*. *C.M.G.:* Mr. I. B. Pole Evans, chief of the division of botany and plant pathology, Department of Agriculture, Union of South Africa. *C.I.E.:* Lt.-Col. W. F. Harvey, director of the Central Research Institute, Kasauli, Punjab, and Dr. E. J. Butler, formerly Imperial Mycologist, Pusa. *K.C.V.O.:* Dr. F. S. Hewett.

THE appeal for help to the scientific and literary community of Russia which we publish elsewhere should meet with a sympathetic response. Since the calamitous political disturbances began in their country many Russian scientific men have taken every opportunity of begging their colleagues and friends in the rest of Europe to help them to emigrate to more congenial surroundings abroad. In very few cases has it been possible to grant their petition. Now that the Bolshevik Government seems to have begun to realise that intellectual life has some value for the nation, it may be best that we should encourage our fellow-workers in Russia to remain at home and give them all possible assistance in promoting learning in the sad circumstances in which they find themselves. We understand that the great libraries, the university laboratories, and the old national collections, at least in Petersburg, are still intact, and that some provision has been made for the small remnant of Russians who are capable of using them. They merely need the stimulus of contact with the centres of intellectual work in other countries and an up-to-date knowledge of the results of research elsewhere. We trust that Britain will take the lead in furnishing this stimulus and supplying the necessary publications to enable Russia again to take a conspicuous place in the world of science, literature, and art.

THE Rockefeller Foundation has presented to the State of Louisiana a tract of country comprising some 35,000 acres known as the Grand Chenier Wild Life Refuge (*Science*, December 3). The land was purchased by the Foundation from individual holders in 1914 in order to preserve the wild life of the country, and it is a condition of the gift, which includes laboratories, publications, and equipment connected with the preservation enterprise, that the tract shall remain as a perpetual wild-life preserve.

IT is announced that Mr. Llewellyn Treacher has been selected for the Foulerton award of the Geologists' Association.

THE Aldred lecture will be delivered at the Royal Society of Arts on Wednesday, January 12, at 8 p.m., by Dr. C. S. Myers, director of the psychological laboratory, and lecturer in experimental psychology, University of Cambridge. The subject will be "Industrial Fatigue." Mr. W. L. Hichens will be in the chair.

Science of December 10 announces that the Elisha Kent Kane gold medal of the American Geographical Society has been conferred on Dr. A. Hamilton Rice in recognition of his pioneer exploratory work in South America; also that the Franklin Institute has awarded the Elliott Cresson gold medal to Dr. W. L. R. Emmet in recognition of his notable contributions to the art of ship propulsion.

DR. E. O. TEALE has been appointed Government Geologist of Tanganyika Colony, formerly German East Africa. Dr. Teale has already had much experience of African geology, having spent several years in Portuguese East Africa, and having been occupied more recently with geological work in Nigeria and Gold Coast Colony. With his former colleague Mr. Wilson he contributed an important paper on Portuguese East Africa to the *Geographical Journal*.

AT the exhibition of paintings by the Birmingham Art Circle in the galleries of the Birmingham Royal Society of Artists there will be on view until January 20 two portraits (by Mr. Bernard Munns) which will be of interest to many readers of NATURE. One is that of the late Prof. John Henry Poynting, an admirable likeness in which the character of the subject is beautifully expressed. This portrait has been painted for the Trustees of the Poynting Memorial Fund, and will be hung in the guest hall of the University at Edgbaston. The other is a fine portrait of the late Prof. Adrian J. Brown, F.R.S. The University already has portraits by the same artist of the late Prof. Charles Lapworth and Prof. P. F. Frankland.

THE results of the balloting in the reorganisation of the International Commission on Zoological Nomenclature have been announced as follows:—*Class of* 1922 (*elected in* 1913): Dr. J. A. Allen, New York, N.Y.; Dr. F. A. Bather, London; M. Ph. Dautzenberg, Paris; Dr. W. E. Hoyle, Cardiff; Dr. K. Jordan, Tring; and Prof. H. Kolbe, Berlin. *Class of* 1925 (*newly elected, vice Class of* 1916): Dr. D. S. Jordan, Palo Alto, Cal.; Prof. A. Handlirsch, Vienna; Prof. R. Monticelli, Naples; Dr. E. Simon, Paris; Dr. H. Skinner, Phil., Pa.; and Dr. L. Stejneger, Washington, D.C. *Class of* 1928 (*newly elected, vice Class of* 1919): Prof. C. Apstein, Berlin; Dr. E. J. O. Hartert, Tring; Dr. Géza Horvath, Budapest; Prof. Louis Roule, Paris; and Dr. C. W. Stiles, Washington, D.C. No majority was obtained for the vacancies caused by the death of Prof. Blanchard and by the resignation of Prof. Roule; accordingly a new vote is being taken. Each class consists of six Commissioners elected to serve nine years, and selected from the zoological profession of the world at large.

AT the annual general meeting of the Faraday Society held on December 13, the following officers and council were elected to serve for the coming year:—*President:* Prof. A. W. Porter. *Past-Presidents:* J. Swinburne, Sir Richard Glazebrook, and Sir Robert Hadfield, Bart. *Vice-Presidents:* W. R. Cooper, Prof. C. H. Desch, Dr. J. A. Harker, Emil Hatschek, Prof. T. M. Lowry, Dr. E. H. Rayner, and Dr. G. Senter. *Treasurer:* Robert L. Mond. *Council:* Dr. A. J. Allmand, Dr. H. Borns, Prof. W. C. McC. Lewis, Harold Moore, Prof. J. R. Partington, C. C. Paterson, Prof. A. O. Rankine, Sir Robert Robertson, Sir T. Kirke Rose, and Dr. W. Rosenhain. Prof. Porter, in proposing a vote of thanks to the retiring president, Sir Robert Hadfield, who had guided the society during the whole critical period of the war, referred to the growth that had taken place in the society's work and in its prestige during that period. He remarked that of the twenty-six general discussions that had been organised by the society, many of them in co-operation with other societies the collaboration of which was greatly appreciated, as many as nineteen had been held during Sir Robert Hadfield's presidency.

THE Report of the Watchers' Committee of the Royal Society for the Protection of Birds for the years 1919–20 is a record of excellent results obtained, but it also reveals how much remains to be accomplished, and could be accomplished if the necessary funds for the purpose were forthcoming. Those at its disposal are wholly inadequate to meet even the expenses already incurred. The society employs twenty-three watchers who are located at seventeen breeding stations annually resorted to by some of the rarer, and hence much persecuted, British birds. Thanks to the loyalty and devotion of these excellent men—they are offered bribes and subjected to threats—it is gratifying to learn that nests of the bittern, Kentish plover, red-necked phalarope, chough, whimbrel, and many other species, including in the south of England the raven and the peregrine, were successfully protected. On the other hand, owing to lack of funds to provide for adequate watching, a lamentable state of affairs is revealed. Thus roseate and Sandwich terns were robbed of all their eggs, and divers, the numbers of which are annually growing fewer, were sadly raided, so that in one case of thirteen nests only three young birds were hatched, while in another out of fifteen nests eight were destroyed. The craze for egg-collecting at the present time is, unfortunately, at its zenith, the excuse being that the specimens are taken for scientific purposes. If scientific results may be derived from the study of the eggs of British birds, it may be safely averred that there is already a plethora of material available for the purpose. It is greatly to be hoped that bird-lovers who are not subscribers to the Watchers' Committee will respond to the society's earnest appeal and help to carry on this highly desirable, patriotic work. The society's address is 23 Queen Anne's Gate, S.W.1.

IN a study of variation in the mealworm, *Tenebrio molitor*, Mr. S. A. Arendsen Hein finds two common colour varieties of the larvæ, chestnut-brown and orange-red, and a rare melanic type with black instead of reddish-brown abdomen, antennæ, and legs. Red and yellow eye-colours are inherited, and the latter is sex-linked. Reduction in the number of tarsal and antennal segments is also based on hereditary factors. The duration of the larval stage is largely controlled by temperature. Females usually produce no eggs without previous mating, and egg-production normally continues for two months.

WE have received vol. vii., part 4 (Series C, Zoology and Botany), of the Scientific Reports of the Australasian Antarctic Expedition, 1911–14, containing the bacteriological and other researches dealing with physiology, dietetics, psychology, etc., by Dr. A. L. McLean. Cultivations from the intestinal tract of some of the mammals and birds (*e.g.* Ross seal and penguins) contain no, or very few, bacteria. Similar results have been obtained in the case of Arctic forms by Levin and others. In other mammals and birds (*e.g.* Weddell seal, sea-leopard, and skua gull) the bacterial content of the intestine was high, containing coliform organisms and sporing bacilli. Cultures of bacteria were obtained from ice, snow, soils, and marine mud. Suppuration was observed in the wounds of Weddell seals, inflicted by the sea-leopard and killer whales, with a bacterial flora of streptococci and staphylococci. Observations on the hæmoglobin values of the blood and on blood-pressure showed little of interest. It was noticeable that the hair of the head and the nails grew very slowly.

VOL. XLIII., article 6, of the Bulletin of the American Museum of Natural History (issued on December 4) consists of an extensive paper on the Lepidoptera of the Congo by Dr. W. J. Holland. It takes the form of a systematic list of the species of that order of insects collected during the expedition sent out by the museum to the Congo region. Although the collection is one of the largest made in recent years in that part of the world, it is very poor in moths, most attention being devoted to the showier Nymphaline and other butterflies. As Dr. Holland points out, the primary aim was to secure vertebrates, and the making of insect collections was a subsidiary object. From among about 9000 specimens there are more than 725 species and varieties. It has only been found necessary to erect two new genera, and the new species and varieties amount to fewer than 80. The largest number of specimens was secured at Medje, near the Nepoko River, in the heart of the forest, from April to September, 1910, and the collection as a whole exhibits a distinct affinity with the West African fauna. The paper is evidently an important contribution to our knowledge of the distribution of Lepidoptera in Africa, and is illustrated by nine three-colour-process plates and a similar number of text figures.

AMONG the creatures that live harmoniously with termites in their nests is a Staphylinid beetle, which, like the familiar "devil's coach-horse," turns its abdomen over its back, but in this case the abdomen is greatly swollen, stretches far forward, and is extended backwards only with difficulty. This beetle, previously referred by Dr. E. Warren to the South American genus Corotoca, has now been more closely investigated by him, and is redescribed as *Paracorotoca akermani* (Ann. Natal Mus., vol. iv., pp. 297–366, pls. xvi–xxi, November, 1920). Dr. Warren finds that, structurally, it is closer to the Malayan Termitoptochus, and infers that the resemblances to Corotoca and other termitophilous beetles are due to the similarity of their environment. Paracorotoca has been found only in nests of the common Eutermes (*E. trinerviformis*) of Natal, and is very rare. The inflated abdomen is almost filled with the greatly overgrown sexual organs. The ova are relatively huge, and this is probably connected with the viviparous production of large larvæ. No similar need exists for the large size of the male organs, and it may be supposed that the stimulus for their growth has been transmitted to the male from the female. How far the termites feed the beetles and in what way the beetles repay the hospitality are questions not yet settled. One curious observation has been made: when termites are alarmed they vibrate their bodies in a characteristic manner, and the beetle does the same. Dr. Warren compares the habit in the termites to the trembling with rage or fear in mammals, and suggests that the intimate association of the beetle with the termites has produced in it a similar nerve-tone.

THE *Journal of the Ministry of Agriculture* for October and November, 1920, contains an interesting account of the work of the new Plant Breeding Institution at Aberystwyth by the director, Prof. R. G. Stapledon. In addition to the laboratories, which are now completed, there is a drying-room and a gardeners' room designed for the threshing and cleaning of small lots of seeds. The land attached to the station includes 4 acres of garden-ground, a 13-acre field of arable land for larger trials, and an adjoining farm of 92 acres. One of the chief problems taken up is that of the improvement of herbage plants for the grassland areas of Wales and the West of England. Of the numerous grasses and legumes being tried the following already show promise: *Phalaris nodosa*, a rich pasture grass from South Africa; *Danthonia pilosa*, from New Zealand; *Eragrostis abyssinica*, which produces hay in portions of Natal and the Transvaal; *Trifolium subterraneum*; and the hairy vetch, *Vicia villosa*. Local indigenous grasses are also being brought into cultivation with the view of improving strains which are already adapted to the conditions. Cocksfoot grass from various countries was grown, and the indigenous plants were found to show greater development and to have the advantage of being later. Experiments are also being taken up with cereals, particularly oats, for high elevations and high rainfall.

THE possibility of recognising shoals and channels from a photographic print and of determining in some measure the shape of submerged land-forms opens a new avenue of approach to the study of submarine geography by the use of aerial photography. The subject is discussed by Dr. W. T. Lee in an article in the *Geographical Review* for November (vol. x., No. 5). A number of finely reproduced photographs by the Air Service of the United States Army illustrate the extent to which the camera succeeds in recording submarine features. Experience seems to show that the best results are likely to be obtained early in the morning or late in the afternoon under an evenly illuminated sky. Either an entirely overcast or a uniformly clear sky is more favourable than a partly clouded sky. Waves appear to have little effect on the visibility of submarine relief, but by the diffusion of reflected light they can at times destroy the effect of the detail on the photographic plate. More research, however, is necessary in order to decide the best conditions for determining clear detail.

THE recurrent subject of the growth of flint is revived by Mr. C. Carus-Wilson in a letter to the *Geological Magazine* for October, where a case is quoted of the inclusion in flint of wood bored by Teredo. The problems that this specimen justly raise in Mr. Carus-Wilson's mind could probably be set at rest, as in other cases referred to, by thin sections cut from the encasing flint, and it is to be hoped that the matter will be pursued further.

MR. S. S. BUCKMAN'S work on "Type Ammonites," finely illustrated by photographs of actual specimens, has reached its twenty-third part, and is already a monument to the painstaking devotion of its author. We fear that questions from other workers as to generic subtleties must make serious inroads on Mr. Buckman's time, since we cannot now think of British ammonites without him. The work is published for the author by Messrs. W. Wesley and Son, Essex Street, London, W.C.2.

TABLES of frequencies of surface-wind directions and cloud amounts at Metz, Mulhausen, Karlsruhe, and Frankfort by Capt. D. Brunt have been published by the Meteorological Office as Professional Notes No. 14. The tables are similar to those given previously for Richmond and Greenwich. They are based on the observations from the German Daily Weather Reports for ten years, 1900–10, excluding 1906. The results are said to differ widely from those for Richmond, where the number of clear skies in the summer is much greater in the evening than in the morning, but the tables in the present publication show only a very slight clearing in the evening in the summer, and in July the evenings are cloudier than the mornings. For the towns dealt with, the most frequent wind directions are north-east and south-west. North-east winds divide into two groups, with clear and overcast skies respectively, and in the summer they give more clear skies in the evening than in the morning, the cloudiness of the weather being apparently controlled by the different weather types. South-west and west winds are said usually to be associated with the passage of depressions across the British Isles, tending to give overcast skies, especially during the morning. They are associated with a greater frequency of clear skies in the evening during the months of September and October. Pilot-balloon results show that at Aix-la-Chapelle

(Aachen) and Frankfort the direction of the wind at the surface is practically the same as at an elevation of 1000 metres, while at Strasbourg the wind at the surface is usually backed two points from the wind at 1000 metres.

WHEN the interpretation of crystal structure on the basis of close-packed spheres was put forward by Barlow and Pope in 1906 it was suggested that the sphere of influence of each atom in a given crystal was approximately proportional to its valency, but that these spheres of influence varied in size in a series of isomorphous crystals in such a way as to preserve the proportionality of their individual volumes to the valencies, whilst the sum of their volumes varied with the molecular volume of the compound. Prof. W. L. Bragg's study of the structure of crystals by means of X-ray analysis, on the other hand, led to the conclusion that each atom has a constant sphere of influence, the atomic diameters of some of the common elements being, for instance, as follows:

F = 1·35 Å.	O = 1·30 Å.	Li = 1·50 Å.	Be = 1·15 Å.
Cl = 2·10	S = 2·05	Na = 1·77	Mg = 1·42
Br = 2·38	Se = 2·35	K = 2·07	Ca = 1·70
I = 2·80	Te = 2·66	Rb = 2·25	Sr = 1·95
		Cs = 2·37	Ba = 2·10

A crucial test of these alternative views can be made most readily by carrying out an X-ray examination of an isomorphous series, and this has now been done in the case of calcite and the isomorphous carbonates of manganese and iron, the Laue patterns from which have been analysed by a novel geometric method by R. W. G. Wyckoff (*American Journal of Science* [iv], vol. l., pp. 317–60, November, 1920). The following results were obtained:

	$CaCO_3$	$MnCO_3$ (and $FeCO_3$)
Distance from carbon to oxygen	1·21 (1·42)	1·22 (1·42)
,, ,, ,, metal	3·04 (2·47)	2·83 (2·24 and 2·17)
,, ,, oxygen ,,	2·30 (2·35)	1·96 (2·12 ,, 2·05)

In this table the distances from carbon to oxygen are constant, whilst the distances from carbon to metal and from oxygen to metal are about 0·26 Å. and 0·34 Å. greater for calcium than for manganese and iron. It should, however, be noted that most of these data differ considerably from those given by Bragg (which are shown in brackets in the table), the deviations rising to 0·6 Å. in the distance from carbon to metal, *i.e.* nearly three times as much as the variation on passing from calcium to manganese or iron.

IN *Science* for October 15 Mr. J. J. Willaman, of the University of Minnesota, directs attention to the possibility of utilising artichoke and dahlia tubers as sources of fructose, which could be used, in place of ordinary sugar (sucrose), as a sweetening agent. These tubers contain the carbohydrate inulin, which on hydrolysis by acids is converted into fructose (lævulose), just as starch is similarly convertible into glucose (dextrose). Taking an average crop of artichoke tubers at 40,000 lb. per acre, and assuming a recovery of 10 per cent. of inulin, Mr. Willaman states that it should be possible to obtain about 4000 lb. of fructose per acre, which is nearly equal to the yield of sucrose from a good crop of sugar-cane and about twice the yield of glucose syrup from an average crop of maize; fructose, moreover, is sweeter than either sucrose or glucose, so that artichokes would appear to have a distinct advantage over either sugar-cane or maize as a source of sweetening material. The author realises that the matter may not be quite so simple as it looks, and he appeals for the inauguration of research by some official or industrial organisation to ascertain whether a presentable fructose can be made from artichokes. These tubers have been used in Germany as a source of alcohol, but that is a simpler proposition than the manufacture from them of a serious competitor with cane-sugar. Artichokes grow well in England, as hundreds of allotment-holders discovered during the war; there are plenty of British chemists familiar with the chemistry of carbohydrates, and our large consumption of sugar is met almost entirely by imports. In view of this, the Department of Scientific and Industrial Research might do worse than take Mr. Willaman's suggestion into serious consideration, if it has not already done so, and, if there is anything in it, arrange to have the necessary research work done in this country.

WE have received a Physical Department Paper issued by the Egyptian Ministry of Public Works on "The Effect of Turbulence on River-discharge Measurements," forming an addendum to a Report on Nile Gauge Readings and Discharges published in March last. Mr. Hurst, Controller of the Physical Department, has prepared this note to prevent any misconception which might arise on the statement of certain views attributed to Mr. Craig, of the Egyptian Survey, in the earlier publication. The Survey of Egypt carried out a long series of river-discharge measurements at Sarras, in the Sudan, the results of which, after making all necessary allowances, showed a considerable divergence from the readings at the Aswân Dam, amounting to about 15 per cent. In 1912 Mr. Craig put forward the suggestion that the variation might be due to the effect of turbulence in the flow, and showed mathematically that reductions in apparent volume might have to be made amounting to as much as 20 per cent. during flood and to 10 or 15 per cent. when the river was low. Experimental investigation, however, has demonstrated that the correction for turbulence at the low stage of the river is negligible. After alluding to some further experiments now being carried on, the paper concludes:—"The effect of turbulence at the low stage is now settled, and the probability is that the amount of turbulence present in the Nile in flood at well-chosen sites will not necessitate any corrections of practical importance. The cause of the difference between the discharges at Sarras and Aswân still remains to be found."

WE have received from Messrs. J. Woolley, Sons and Co., Ltd., of Manchester, a copy of their "Scientists' Reference Book and Diary," price 3*s*. 6*d*. The book contains much interesting and useful information in addition to that usually found in diaries. The first section deals with the physical sciences, and contains a short article on recent advances in physics; another portion is devoted to chemical tables, and includes convenient data relating to specific gravities, solubilities, strengths of solutions for analysis, etc. A section is also devoted to scientific societies and departments, in which a brief account is given showing the address and the officials of each. The diary is well bound, and makes a convenient pocket-book for ready reference and notes.

MESSRS. H. F. AND G. WITHERBY are about to publish vol. i. of "A Manual of the Birds of Australia," edited by G. M. Mathews and T. Iredale, illustrated by coloured and monochrome plates.

A NEW edition of Sir Edward Thorpe's "A Dictionary of Applied Chemistry" is announced by Messrs. Longmans and Co. Vol. i., A to Calcium, is promised for January, and vol. ii. for early in the coming summer. The work, which has been carefully revised, will be in six, and possibly seven, volumes.

Our Astronomical Column.

COMETS.—Mr. Woods has communicated by cable the following elements of Skjellerup's comet. Elements deduced by M. Ebell from observations on December 13, 17, and 18 last are also given. Both are for the equinox of 1920·0:

	Woods	Ebell
T in G.M.T.	Dec. 11·11	Dec. 13·46512
ω	341° 10′	344° 9′ 47″
☊	107 47	107 38 7
i	22 12	24 4 7
log q	0·06047	0·06476

Mr. Woods's elements make the position at midnight on January 20: R.A. 11h. 7m. 17s., N. decl. 36° 22′. The position given last week was: R.A. 11h. 17m. 42s., N. decl. 38° 24′.

Herr Hoffmeister observed the comet at Sonneberg on December 18. He described it as a circular nebulosity 8·0′ in diameter, total light 9th magnitude, nucleus 11th magnitude.

An observation by Mr. R. L. Waterfield on December 31 indicates that Mr. Woods's ephemeris is very near the truth.

The two longest-known comets of short period (those of Encke and Pons-Winnecke) are both due at perihelion in 1921. There is a simple method of predicting the date of perihelion of the former comet within a day or so. Eighteen revolutions of the comet occupy 59½ years, equal approximately to five revolutions of Jupiter and two of Saturn, so that the perturbations nearly repeat themselves after this period. The following have been the duration of eighteen revolutions at recent returns:

	Interval (days)		Interval (days)
1845 to 1905	21704·28	1855 to 1914	21705·75
1848 to 1908	21704·08	1858 to 1918	21705·92
1852 to 1911	21705·33	1862 to 1921	21706·1 about

Perihelion should occur about July 13·4.

Winnecke's comet is subject to large perturbations by Jupiter, and no simple cycle is available in this case. The best estimate that can be made of the date of perihelion is the end of June, but this may be a month in error. The period of this comet has increased by four months in the last century, and the perihelion distance has increased from 0·77 to unity. This has resulted in introducing it into a new shower of meteors, first seen on June 28, 1916, the connection of which with Winnecke's comet was quickly detected by Mr. Denning. These meteors should be in evidence next June. The radiant is about 240°+50°.

Another periodic comet may return this year, 1846 IV (de Vico). The most probable period is 75·7 years, which would make the next perihelion November, 1921, but the uncertainty is fully three years. The comet will first become visible to southern observers, but it will move northward very rapidly, its inclination to the ecliptic being 85°.

DISAPPEARANCE OF SATURN'S RINGS.—The earth passed through the plane of the rings on November 7, and a joint paper on the phenomena presented about that date, by Messrs. Hepburn, Ainslie, Steavenson, and Waterfield, was read at the R.A.S. meeting on December 10. They observed with the 28-in. equatorial at Greenwich, by kind permission of the Astronomer-Royal. On November 6 the ring was easily visible, but on the following night no trace whatever was visible outside the ball. This was confirmed by Prof. Barnard, observing with the 40-in. at Yerkes Observatory, who estimated that the thickness of the rings could scarcely exceed 40 miles. A few days later, in spite of the dark side of the rings being turned towards us, the observers at Greenwich could clearly see a number of luminous patches outside the ball, which they were able to identify with the brighter regions of the ring; they noticed that these regions continued visible when twilight was far advanced and long after the inner satellites had disappeared. This would appear to indicate that an appreciable amount of sunlight is able to penetrate the ring, illuminating the particles on its remote side. It will be remembered that a star was recently seen through the ring, so it is not surprising that sunshine should penetrate it.

The ring will again be edgewise to the earth on February 21 and August 2, and to the sun on April 10.

KODAIKANAL OBSERVATORY.—Bulletin lxiii. of this observatory deals with the direction and aspect of the dark filaments which are such a conspicuous feature of spectroheliograms in Hα light, and are known to be prominences projected on the solar disc. Their azimuth is first studied, and shown to be a function of latitude. Near the equator they lie along a meridian; as we recede from the equator the polar end of the filament swings eastward. The mean inclination to the equator is 40° in latitude 30°, and 0° in latitude 60°.

The explanation suggested is the easterly drift produced by the excess of easterly motion at the equator. It was inferred from this that the high-latitude filaments are older than the equatorial ones. However, a study of the history of particular filaments from the photographic records did not give clear evidence of this difference of age with latitude.

Two interesting features of the prominences are discussed: (1) Those on the disc are flanked by a bright strip, which is easiest to see near the limb. It is interpreted as showing that the prominences rest on a bright base which is hotter than the ordinary chromosphere. (2) The lower portion of prominences seen in profile outside the disc is frequently obscured by a dark strip. It is suggested that the central region of a prominence is the hottest, and that the lower portions of the cooler outer envelope may be dense enough to absorb light.

Birth and Growth of Science in Medicine.[1]

By SIR FREDERICK ANDREWES, F.R.S.

THE aim of science is to discover the "laws of Nature," and in its truest, though narrowest, sense it is the pursuit of this knowledge for its own sake, irrespective of any practical use to which it may be put. The primary aim of medicine is the practical one of healing the sick or of preventing disease, and therefore, in the narrower sense, medicine is not a science, but an art. Physiology, pathology, and pharmacology are sciences in the strictest sense; medicine is the art of applying the laws established by these sciences to the prevention or cure of disease. More than this, it is the very human art of treating the patient as well as his disease. But in a broader, and surely more natural, sense we may regard medicine as a science. Pathology may, it is true, be pursued as an abstract subject, but in real life it is inseparable from medicine. Treatment and prevention are so intimately based upon a right understanding of the nature of disease and of the laws which govern its course that I refuse to separate pathology and medicine. It has too long been the fashion to limit the sphere of pathology to the dead-house and the laboratory; its field is equally at the bedside, and, indeed, I would assert that there is no method of studying the natural history of disease which pathology may not claim as its proper province. By Harvey's injunction I am to admonish you to seek out the truths of Nature by observation and by experiment. These are two different ways of pursuing a subject, and, indeed, the concrete sciences have been divided into the "observational" and the "experimental"; anatomy is an observational science, physiology an experimental one. The observational sciences long preceded the experimental, and in pathology and medicine, which partake of the nature of both, the experimental method is of late growth.

My aim is to trace, so far as I may in the allotted span of time, the influences which have governed the growth of our knowledge of disease; to pursue them to their beginnings rather than to record their final results. I cannot, indeed, hope to say anything new; I can only endeavour to place before you the facts to be gathered from literature in the way in which they group themselves in my own mind.

In his suggestive little book entitled "The Revolutions of Civilization" Prof. Flinders Petrie has pointed out that culture is an intermittent phenomenon. No civilisation in the past has proved permanent, and he estimates the average duration of any given period of culture at about 1500 years; in Egypt he traces eight such periods. In Europe we are aware of three great periods of civilisation during the past five thousand years—the Mediterranean or Minoan, with its headquarters in Crete, from 3000 to 1200 B.C.; the Classical, of which Greece was the intellectual fountain-head; and the Modern or Western, in which we are still living.

So far as we are aware, the earliest attempts at science began in Ionia some six centuries before Christ, and the name which I would first commemorate as a spiritual benefactor of this college is that of Thales of Miletus. I might have chosen Empedocles or Pythagoras, but we may let Thales, as the first of the succession of early Greek thinkers, stand as the prototype of the group of men who laid the foundations upon which science was to be built by future generations. Doubtless they had acquired what they might of the lore of older civilisations, but they seem to have been the first to pursue abstract knowledge. Until their day men had been content to accept any foolish myth about the nature of the world and of the things they saw around them. The service which Thales and his successors rendered to mankind was that they rejected all fabulous tales and began to think for themselves how things had become such as they saw, definitely reaching out after the laws which they felt sure must govern Nature. Their great contribution to science was to establish that atmosphere of intellectual liberty which rendered science possible. It says much for the liberal spirit of that age that these men, who broke with all the cherished traditions of the past, were not, as a rule, reviled for impiety, but received universal honour. Thales was accounted one of the Seven Wise Men of Greece.

But let me now consider what the earlier Greeks did for medical science. Medicine of a sort and rude surgery must have been transmitted even through the dark ages, handed down, it is said, by special families, the Asklepiadæ, just as the epic tradition was passed along by the Homeridæ. Certain rules of surgery and the practices of blood-letting and purgation are known to be of immemorial antiquity, but for the most part the medical practice of those times seems to have been bound up with fetish worship and superstition. There is no evidence that Egypt had any true medical science to impart, and our knowledge of Minoan medicine is limited to the single fact that in the great palace at Cnossus there existed a system of sanitation so good that it was never equalled until the reign of Queen Victoria. We may be quite sure that the inquisitive and receptive Greek mind was quick to pick up what it could from the older civilisations, and then, in accordance with its peculiar genius, it proceeded to develop it out of all recognition.

Medicine entered upon its first scientific stage with the Greeks; it became an observational science. More than this; just as in other matters the philosophers had put away the myths and fairy tales of their ancestors, so, too, in medicine they rejected the magic and fetish worship which had hitherto formed so large a part of practice. This was one of the greatest services rendered by the Greeks to medical science. Æsculapius was worshipped at numerous temples, and thither the sick were brought to receive such benefit as they might from the rites of the god. But at such health resorts they were also subjected to other influences—careful diet, pure water, rest, and cheerful associations—and when improvement occurred the physicians had the acuteness to perceive that this simple treatment had probably more to do with the result than the religious rites.

This brings me to the second name which I naturally commemorate to-day—that of Hippocrates of Cos—the first great clinician of whom we have any knowledge, and one whose name will always be associated with the phase which Greek medicine had now reached.

When Hippocrates was born, about 460 B.C., observational medicine had attained a considerable pitch of excellence. He doubtless imbibed the teachings of other good physicians who had gone before him, but the veneration in which Hippocrates was held by the Greeks themselves assures us that he was a man of outstanding character and attainments. We can,

[1] From the Harveian oration delivered before the Royal College of Physicians of London on October 18, 1920.

however, judge of him more directly. It is certain that only a small part of the Hippocratic treatises which have come down to us are from the pen of the master himself, but we may reasonably take them, as a whole, to represent his teaching, and they give us a fair idea of the stage at which the best Greek medical science had arrived in the fifth century B.C. It was a simple and rational medicine based on careful clinical observation and on a watchful study of the results which followed hygienic treatment. The healing powers of Nature formed a leading tenet of the Coan school; we may almost regard Hippocrates as the founder of sanatorium treatment. Perusal of those of the Books of Epidemics which are most certainly by Hippocrates himself shows that he was an admirable case-taker; in the light of our present knowledge we can readily make a diagnosis from many of his descriptions. His medicine shows, of course, the natural limits of a purely observational science; it knows little of anatomy and less of physiology; its crude pathology is based on the doctrine of "opposites"; the idea of experiment as a means of investigation has not yet arisen. Yet in spite of this, the school of Cos is a landmark in the history of rational medicine.

The centre of interest now shifts elsewhere, and especially to Alexandria, but it remains Greek. Alexandrian culture represents a sort of continuation of that of Athens, though, perhaps, in comparison smacking somewhat of Wardour Street. The great creative age in art and poetry had gone by; it was a period of imitation in art, and in literature largely a time of scholiasts and commentators on the better work that had been done before. But here we have an excellent illustration of Prof. Flinders Petrie's dictum that in each period of culture science reaches its prime long after art and literature have begun to decline. For all the branches of science then extant continued to advance in Alexandria. I need scarcely recall how mathematics and astronomy flourished under the Ptolemies, and in medical science the Alexandrian school maintained its premiership for many hundred years.

Anatomy and physiology form a necessary basis for medical science, and much as the earlier Greeks had done for medicine, they had lacked any adequate knowledge of these subjects. The later Greeks proceeded to remedy this defect. The practice of dissection became established, and anatomists must look back to the Alexandrian school for the foundation of their science. I must pass over Herophilus and Erasistratus and commemorate the later Greek school in the person of its most distinguished alumnus, Galen. Roman medicine, like its art, was wholly Greek in origin; its great physicians received their training in Greek schools, and Celsus, the best-known writer on medical subjects, was not himself a practitioner of medicine. Thus, though we associate Galen with Rome, I must commemorate him as a Greek—the last and, in many ways, the greatest of the Greek physicians.

Nearly six hundred years had passed between Hippocrates and Galen, and when we compare the two it must be remembered that Galen had the advantage of that six hundred years of medical experience. It gave him a wider outlook, and thus made him a better physician, though I conceive Hippocrates, considering his times, to have been the bigger man. I do not propose to dwell on Galen's eminence as a physician, though he stood far above all others of his age. His real claim to immortality may be put into a few words: he was the first to make systematic use of the experimental method in medicine, and he founded the science of physiology. His experimental discoveries in physiology, and particularly in the domain of the nervous system, entitle him to be called the father of that science. Galen must also be credited with a great advance in pathology. The earlier Greeks had regarded internal medicine from a purely humoral aspect; the later Greeks began to recognise affections of certain definite organs, but Galen developed this conception beyond any of his predecessors.

With Galen we come to the end of the great age of classical civilisation, and it will be fitting, before leaving it, to summarise what Greek genius had accomplished in medical science. An atmosphere of intellectual liberty essential to the birth and growth of science had been established by the Greeks; they had developed the love of knowledge for its own sake. Their shrewd observation had transformed medicine from a medley of traditional empiricism and superstition into a natural science; they freed it from magic and laid the foundations of a rational treatment of disease. Towards the close of their epoch they devised the experimental method, and used it to found the science of physiology. Indirectly we owe to them the laws of clear thinking in medicine and in the other sciences, and the development of mathematics and mechanics.

When the Minoan civilisation passed away the Greeks had been compelled to begin again almost from the beginning. There was no such complete break between the classical period and our modern civilisation; much was handed on by direct tradition, and vastly more by written manuscript. Nevertheless, after the fall of the Roman Empire, Europe had to be remade, and to pass through its dark ages before the dawn of a new culture. The new mixture of races seems to have been incapable of intellectual achievement until the ordained incubation period was over, and that period was at its darkest from the fifth to the tenth centuries A.D. Medicine shared the fate of the other sciences, and what was not forgotten became debased by admixture with Eastern magic and superstition.

The dominant power in Europe during this period was the Church, and, although its conservatism had a wholly deadening influence as regards the advance of science, it did much to preserve the culture of classical times. In the seventh century occurred the last of the four known Arab migrations which have overwhelmed neighbouring peoples; it spread not only over Western Asia, but also round the Mediterranean. Whatever may have been the primitive culture of these Arab invaders, they presently acquired a high degree of civilisation. They were a keen-witted race, quick to assimilate the culture with which they came in contact, and this was largely Greek in origin. For some hundreds of years the Moorish Empire in Spain was far in advance of the rest of Europe in literature, in science, and in medicine. The best medical works of classical antiquity were translated into Arabic, and it is by this strange route that much has come down to us which would otherwise have been irretrievably lost. Their chief share in medicine was to absorb and transmit the knowledge of the Greeks. Medicine reflects the spirit of the Dark Ages in Europe; the traditions of the past were still supreme, and Galen was the god of the medical world. Men felt him to have been a better man than themselves, as in truth he was, and it was enough that Galen said this or that, or that his writings could be interpreted in such and such a sense, and there the matter ended.

Then, in the fullness of time, after more than a thousand years of intellectual slumber, men again began to think for themselves, just as the Ionian Greeks had done twenty centuries before. The Renaissance was at first literally a revival of learning, due to the renewed study of the Greek language and the discovery of much of the classical literature which had been hidden away in the libraries of the East. The first effect of the revival was to strengthen the position of Galen. With the revival of Greek in the fifteenth century his original writings became accessible, and manuscripts hitherto unknown came to light. It became the aim of the scholars of the time to translate these works into polished Latin for the benefit of those unacquainted with Greek. Amongst the medical humanists, as they are termed, was the founder and first president of this college. There is no more honoured name in scholarship than that of Linacre, but it is instructive to note the difference between his mental attitude and that of Harvey, little more than a hundred years later. Linacre stands for the revival of learning, Harvey for the intellectual quickening that revival was to engender. The avowed aim of the medical humanists was not the advance of medical science, but a return to the uncorrupted knowledge of the Greeks; the thought and science of antiquity were still held so immeasurably superior to anything that modern times could produce that no advance was contemplated. But the seed was sown. Greek literature was the product of an original creative activity and a mental freedom to which Europe had been long unaccustomed. Men could not study it without at the same time drinking in something of the spirit in which it had been conceived and which animates it for all time. This was our true heritage in the Renaissance, and once again imbued with this spirit men felt at liberty to ask whether the ancients were always right and to criticise and test their statements. The reign of mere authority came to an end, and science recommenced that advance which has continued to the present day.

The first science to bear new fruit was anatomy. It was in Italy that the resurrection began, and the book written by Vesalius on "The Structure of the Human Body," published in 1543, set the seal upon the new method—the appeal to fact instead of to dogma. We all know that the truth as to the pulmonary circulation was first ascertained, while it was reserved for Harvey to demonstrate the systemic circuit. The method of experiment as an adjunct to observation, instead of being delayed for hundreds of years, as it had been amongst the Greeks, was now, thanks to Galen, an instrument ready to hand. And thus it came about that when a man arose deeply imbued with the true spirit of science and capable of using this instrument with intelligence and an open mind, his study of the circulation was at once rewarded by a discovery of capital importance.

William Harvey stands as one of the landmarks in the history of medical science. His was the first scientific discovery of absolutely first-rate importance to be made by the application of the methods and spirit now revived from ancient times; he possessed the vision, the power of imagination, as well as the needful industry and patience in gathering his facts and in devising his experiments.

Harvey has left us two treatises of unequal greatness. The "De Motu Cordis" has no need of any introductory disquisition on scientific method, for it itself is the method incarnate. It is the mature work of a master who is sure of his ground; it sweeps us along from one short chapter to another, each filled with accurate observation and close reasoning, so that no doubt or hesitation is possible to the reader.

But he also essayed to solve other biological problems, for which his means were not adequate, and the "De Generatione," which he was reluctant to publish, is reading of a different kind. The most instructive part of this treatise is perhaps the introduction on scientific method, "Of the Manner and Order of Acquiring Knowledge." Here Harvey in his later age sets forth the principles which had guided him, with Aristotle as his leader, in his life's work, and we realise how truly scientific were his methods.

With Harvey, we feel that medical science has fairly entered the right path. The conditions essential to scientific progress—freedom of thought, accuracy of observation, imagination, experimental verification, and logical reasoning—all are exemplified in Harvey's work.

There is room for difference of opinion as to the impulses from external sources which have had the most far-reaching effects upon medicine since Harvey's day, but I would name four as of exceptional importance. They are the invention of the compound microscope, the development of chemistry, the acceptance of the doctrine of evolution, and the discovery of the relation of micro-organisms to disease. The microscope was invented in Holland late in the sixteenth century, but its possibilities as an aid to anatomy were not at first grasped, and it was not until after Harvey's death that Malpighi actually saw the capillaries and the contrary direction of the bloodflow in arteries and veins. The rise of histology from that time forward has transformed our ideas of the structure of the body, and with each improvement in the microscope our horizon has widened. We have passed from the organ to the units of which it is built up, and Virchow's "Cellular Pathology" marks an epoch in medicine. To-day we are a stage further, for the inquiry is being pushed into the more intimate structure of the cell itself, in the hope of revealing the nature of the processes by which it carries on its work.

The rise of physics and chemistry has been even more fruitful for medicine. We cannot nowadays consider them separately, so closely merged have they become. We recognise the fundamental importance of these sciences for the right understanding of physiology and pathology by placing them at the root of medical education.

Chemistry has influenced medicine from the days of alchemy onwards; Paracelsus and Van Helmont stand out as picturesque figures in its history. In England the rise of physics and chemistry began in Harvey's lifetime with those meetings of scientific men which later gave birth to the Royal Society. It must not be forgotten that the work of such men as Boyle, Hooke, Lower, and Mayow practically solved the problem of respiration not long after Harvey's death—a problem second only in importance to that of the circulation—though a century was to elapse for its full meaning to become clear with the discovery of oxygen. Every advance in physics and chemistry has borne fruit for us in its turn; to-day we can almost affirm that the chief issues in physiology and pathology are to be sought in the chemical activities of the human body. These, again, are bound up with physical conditions, and there is one recent branch of chemistry the possibilities of which are only beginning to be appreciated in medicine. If we reflect that the body, from a chemical point of view, consists almost entirely of colloids, the behaviour of which is still imperfectly understood, it will be realised that advances in colloidal chemistry are destined to throw a flood of light upon the processes of vital activity.

The doctrine of evolution has scarcely received the attention it merits as a factor in modifying the opinions of medical science. So long as it was believed that the body, with all its natural functions, had been created from the first in its present condition, there was little room for inquiry into the origin of those functions, and still less into that of morbid processes. Darwin has changed all this, as a single instance will suffice to show. Metchnikoff's studies on the comparative pathology of inflammation have taught us that this is not a diseased state, but a purposeful reaction against injury, gradually perfected in passing up from the lower to the higher animals. Almost without our being conscious of it, the idea of evolution has gradually effected a great change in the point of view from which we regard a large number of diseases, the symptoms and morbid changes in which we now understand as efforts of the body to maintain its integrity in face of the injurious agencies which threaten it. One might almost rewrite pathology from the evolutionary point of view

Last, but not least, of the great changes which have swept over medical science is that which was due in the first place to Pasteur, carried on by Koch, and brought to triumphant practical application by Lister. The discovery of the true nature of infection has of necessity transformed the outlook of medicine and surgery, but bacteriology and its daughter science immunology would demand a Harveian oration to themselves.

We loosely speak of such fundamental discoveries as those I have just mentioned as producing a revolution in medical science. It is not revolution, but upward growth. With the establishment of each great principle we gain a fresh height from which the field of science takes on a new and wider aspect, and we may be confident that we shall reach yet greater heights to reward us with an even ampler range of vision. There is no sign that the vitality of science in our civilisation is in any way spent; on the contrary, its fertility is unchecked. During the late war we saw for the first time the scientific forces of this country fully mobilised, and no previous five years have seen so many scientific problems brought to a successful issue. So forcible has been the lesson that science has gained mightily in public estimation, and research is on the lips of everyone. New facts are being gathered in, old facts are coming to be seen in a new light; we are almost bewildered by our own progress. The workers in the field of medical science are many, and it may not be given to any one of us to make an immortal discovery, such as that of the circulation of the blood. But the humblest of us can work in Harvey's spirit and bring his contribution to the building up of knowledge in the full assurance that even a single stone, if honestly and truly squared, will in due time find its proper place in the fabric.

Wheat from Seed-bed to Breakfast-table.

"THE History of a Grain of Wheat from the Seed-bed to the Breakfast-table" formed the subject of the concluding evening discourse given by Sir Daniel Hall at the Cardiff meeting of the British Association, and an account of it appeared in the October issue of the *Journal of the Ministry of Agriculture*. Of all industries there is not one which is older, more universal, or more essential than the growing, grinding, and baking of wheat and its kindred food-grains. Yet, in spite of the extreme age of the industry, the various processes involved in the passage of the wheat-grain from its seed-bed to the breakfast-table still demand the close attention of the best obtainable research men of the day; for it is only by research and by the utilisation of the results so obtained that the increased food production necessary for supplying the needs of the world's growing population can be attained.

Many experiments have been made to try to bring about an increase in yield by treating the seed either by electricity or by soaking it in some nutrient fluid. The results of these experiments are very doubtful, and it is improbable that such treatment can affect the ultimate yield. Attention has also been paid to the influence on the wheat yield of the rate of sowing. Ordinarily, wheat sown at the rate of $2\frac{1}{2}$ bushels per acre gives a thirteenfold yield, but isolated wheat-plants are capable of giving more than a hundredfold yield. It is hoped that by using a suitable machine a perfectly effective seeding can be attained with 1 bushel per acre, and such a reduction in the amount of seed sown would mean a considerable gain to the country. Improvement in the quality of wheat grown has been brought about by careful breeding work. Prof. Biffen, working on Mendelian principles, has obtained a variety of wheat, "Little Joss," which produces very good crops on certain soils because of its resistance to rust attacks, the rust-resistance power having been introduced into the grain by careful selection and breeding. Another wheat, "Yeoman," has been bred for the high milling quality of the grain, and on soils to which it is suited the "Yeoman" wheat yields a very heavy crop, while the quality of the flour is almost equal to that obtained from the best Canadian grain. At the present time millers are compelled to mix strong foreign wheat with our home-grown wheat in order to produce bread of the spongy type desired by the public, but it is hoped that extension of Prof. Biffen's work will ultimately supply strong wheats of the "Yeoman" type suited to the varying conditions of all our different wheat-growing districts, and in this way the millers may be rendered independent of foreign wheats.

Although wheat is *the* crop for breaking in virgin land, yet it will not stand competition; at Rothamsted a wheat crop left unharvested to sow itself without further cultivation entirely disappeared in a grassy wilderness in three years. Wheat, though thus dependent on cultivation, possesses a remarkable power of yielding a good crop upon all sorts of soil. One of the Rothamsted plots has carried wheat for seventy-seven successive years without any manure, and the yield is still about 12 bushels per acre—approximately the average crop for the wheat-lands of the world. The manurial requirements of a wheat crop have long since been decided, and the problem now is to prevent the lodging which occurs with big crops on good soils. It may be possible to breed varieties with stiffer and shorter straw, or it may be that manurial treatment, time of sowing, width of rows, and spacing of the seed have some effect on the lodging, or, again, there may be some actual disease factor involved. All these points are being investigated.

The growth of the wheat-plant, so far as gathering material from the air and from the soil is concerned, is practically completed about five weeks before the grain is harvested. This latter period is occupied by the transference of stored-up food from the leaves and stem to the seed. The transference, however, is never complete, and the straw still retains about half of the valuable material manufactured by the plant. Since the amount of such material depends largely on conditions of soil and water-supply, which are outside our control, one line of development must be to increase the migration into the seed. This is especially urgent in drier countries where insufficient water-supply sets a definite limit to the amount of growth. With regard to the flour, considerable differences in milling operations have been brought about under the stress of war. The miller's object is to crack the wheat "berry" with the least possible breaking up of the husk, so that the endosperm falls out in a clean condition. The endosperm is the most digestible part of the grain and yields the best white flour. Before the war only about 68 per cent. of the weight of grain was recovered as white flour, while the remainder passed into various offals. During the war the extraction of flour from wheat rose to more than 90 per cent.; this brought into use certain valuable food elements which, however, are not suited to all constitutions.

Prior to the war only one-fifth of the wheat we consumed was home-grown; the rest came from North and South America, Russia, India, and Australia. Some of these supplies are now cut off, and although America has considerably increased her wheat acreage, the world's supply is still perilously short. For the next year the supplies are safe enough, but the permanent position is by no means assured. Unless more land is put under wheat a bad crop in one or two of the exporting countries would create a serious world shortage, so that as a national insurance we must grow more wheat. We can extend our acreage, and we can increase our production on the existing wheat-land, but in both cases better skill and more knowledge are required. The country, then, must be ready to encourage the attainment of knowledge, for "on knowledge hangs our assurance of a progressive food-supply in the future."

The Origin of Primary Ore Deposits.[1]

THE author commences at the period when the outer silicate shell of the earth was molten. The primeval magma is regarded as having been practically homogeneous and containing about 60 per cent. of combined silicates. All water was then in the atmosphere, giving a pressure more than 300 times as great as at present. As temperature fell, water and oxygen were absorbed; crust-formation, foundering, and resorption went on for a long period, producing a flat temperature gradient in the liquid. Viscosity eventually rendered further foundering impossible; the crust became permanent, granite developed, and below it the segregated basaltic magma long remained liquid. At this stage the isostatic balance was adjusted. Ore-minerals in large quantity were given off at the surface of the granite; these were denuded and dispersed in sediments and solution. This, with later absorption by intruded basic magma, is assumed to have been instrumental in causing the present erratic distribution of primary ores. All so-called water in magmas is held to exist in combination as hydroxyl with silica not in solution as a gas.

Magmatic differentiation is regarded as having been caused by the agency of silicic acid—silicon combined with hydroxyl—which extracts potash alumino-silicate producing a solution lighter than, and immiscible with, a melt of basic felspars and ferro-magnesian minerals. It is believed that in this way the first great split of primary magma into the world-wide granitic and basaltic types was brought about. Evidence regarding the existence of silicic acid in magmatic liquids and elsewhere in Nature is adduced. The ultimate result of the action of water on rock magmas is that silicates are completely removed and a residue of ore-minerals such as magnetite, ilmenite, and chromite left.

Vein-fissuring was brought about in and above batholiths by the expansive force due to the increase in solid specific volume of various elements. This increase is very considerable, exceeding in amount the contraction on solidification of the granite, and continues throughout the whole of the crystallisation period. The effect of this force appears in waves as fissures in successive series. These developed very rapidly, were instantly filled with magmatic mother-liquor, and were quickly sealed by the deposit of solids therefrom.

Quartz is almost always present in veins along with ore-minerals, and silica often occurs in solution in thermal springs, especially such as carry gold, arsenic, antimony, and mercury. For these and other reasons it is regarded as probable that primary ore-minerals passing up from magmas to veins do so in silicic acid solution, and possibly in combination. The deposition of these ores is usually caused by loss of heat and reduction of pressure. It is believed that there are definite, but narrow, limits of temperature between which each ore-mineral develops. These correspond to the temperatures in the strata at the bottom and the top of the ore at the time of deposition. Ore persisting for a vertical depth of 2000 ft. would, therefore, indicate normally a temperature range of 20° C.

The pneumatolytic theory of the origin of the high-temperature ores is rejected because the phenomena of their occurrence are quite inconsistent with what would result if these metals had been given off as gases by magmas. The boiling points of tungsten fluoride (19° C.) and tin fluoride (705° C.) are so far apart that it would be impossible for wolfram and cassiterite to have developed in contact with one another, as they frequently do. Accessory minerals such as fluorite and tourmaline lose the genetic significance usually attached to them owing to the fact that they are not invariably present with tin and tungsten ores, and are frequently associated with a variety of other ores which are admittedly of hydrothermal origin.

In introducing the paper the author directed attention to the probable importance of variations of pressure in ore solution and deposition. Separation from simple solution would involve deposition of ore along the whole upward course of the solvent. This does not take place, the end being usually abrupt in an upward direction. The phenomena in Nature seem to indicate that reduced pressure causes dissociation and, at some point, the total removal of ore from solution. High temperatures and pressures are not entirely correlative, and, since they usually accompany one another in Nature, it is possible that as regards ore-deposition we may in the past have been confusing the two.

[1] Abstract of a paper by J. Morrow Campbell read before the Institution of Mining and Metallurgy on October 21, 1920.

University and Educational Intelligence.

BIRMINGHAM.—The Tebbutt lectures on administration will be given during the coming term as follows: "The Central Departments of Government and their Relation to Local Administration," by Prof. W. G. S. Adams; "Municipal Administration," by Mr. Arthur Collins (treasurer of the City of Birmingham); "Educational Administration," by Sir Graham Balfour; and "Business Administration," by Mr. Gilbert C. Vyle (managing director of Avery's, Ltd.). The lectures will be open to the public.

SIR WILLIAM BRUNYATE has been appointed Vice-Chancellor of the University of Hong Kong in succession to Sir Charles Eliot.

IT is stated in *Science* of December 3 that an anonymous gift of 200,000 dollars has been made to the fund which is being raised by the American Engineering Foundation for the promotion of research in science and engineering.

A COURSE of ten lectures will be given at the Horniman Museum by Mr. F. Balfour-Browne on "Insects in Relation to Agriculture and Disease," beginning on Saturday, January 15. The course is primarily for teachers, but other persons will be admitted so far as accommodation permits; admission will be by ticket, which can be obtained from the curator at the museum. There will also be a series of ten free lectures on Saturday afternoons, starting on January 15, which will be of a simple, popular nature; two lectures each will be given by Mr. F. Balfour-Browne, Mr. E. Lovett, Dr. W. A. Cunnington, and Miss M. A. Murray, and two further lectures by Mr. H. N. Milligan and Mr. A. R. Wright.

AN election to a research studentship will take place at Trinity College, Cambridge, during July next and in each following year. The studentship will be open to graduates of universities other than Cambridge or to men who can show evidence of exceptional qualifications for research who are not members of the University of Cambridge. A candidate must obtain permission from the Board of Research Studies to enter the University as a research student, and will be expected to proceed to the new research degree of Ph.D. which has been established. The value of the studentship will vary according to the student's pecuniary circumstances, but will not exceed 200*l.* per annum, and the studentship will be tenable until the student is of standing to proceed to the degree of Ph.D. Applications should reach the Senior Tutor, Trinity College, Cambridge, not later than July 25.

THE British Lampblown Scientific Glassware Manufacturers' Association, Ltd., has arranged a series of lectures on glass in connection with the lampblown glass industry. Prof. W. E. S. Turner will deal with the manufacture and the properties of glass tubing and rods (three lectures); Mr. English will deliver three lectures on the manipulation of glass and the graduation of apparatus; Mr. Higgins will give three on thermometry and thermometer testing; Mr. Stott will deal with volumetric glassware (two lectures); and Mr. Davis will give the concluding lecture on technical points in the manufacture of bench-blown chemical glassware. The lectures will be delivered at the Northampton Polytechnic Institute, one every week; they commenced on Wednesday, January 5. Members of the association can attend the course free; others will be charged 2*s.* 6*d.* per lecture, or 10*s.* 6*d.* for the whole course. Further information can be obtained from Mr. W. H. Ashfield, British Lampblown Scientific Glassware Manufacturers' Association, Ltd., 2–3 Duke Street, St. James, S.W.1.

SOME interesting figures showing the salaries during 1920 of university and college officials in the United States are published in Bulletin No. 20 (1920) of the Bureau of Education. Data from 401 institutions have been collected, and, so far as possible, only salaries which recompense full-time service are given. Names are omitted, but the institutions dealt with are numbered and grouped in geographical divisions. In the detailed statements the president's salary is given, and succeeding columns show the number and salaries of the various deans, professors, associate and assistant professors, instructors, and assistants who are employed by the various institutions. Summaries are also provided of the various salaries which are allotted to the different posts, and these again are drawn together in two tables which show the maximum, minimum, average, and most frequent salaries attached to different offices in public and private institutions. The average salary for every post is higher in the former than in the latter type of establishment, due in part, no doubt, to the large number of small schools included in this class.

AFTER a break corresponding to two academic years, statistics are again available showing the number of doctorates in science which have been conferred in American universities (*Science*, November 19). In the year 1919–20, 328 such degrees were conferred by 31 institutions, as compared with 332 doctorates of 28 institutions for the year 1915–16, showing that normal conditions have been practically regained. As in previous years, the Eastern universities have conferred the greater number of degrees; Chicago University continues to head the list with 59, and this year Cornell University follows with 35 doctorates. Interesting figures are also given which show the distribution of the degrees among the various departments of science schools for the years 1912–16 and 1919–20. Chemistry continues to claim the greatest number; last year 96 doctorates were conferred in that subject—a total which is 19 short of the number given in 1916. Comparing the numbers for degrees in other sciences for the same two years, it is noteworthy that those conferred for physics and mathematics have decreased by 14 and 15 respectively, while the numbers for botany, zoology, and psychology have increased, the latter from 19 to 40. The increase is interesting because from the numbers given in previous years attention to that subject appeared to be declining steadily. No doctorates were conferred specifically for palæontology, mineralogy, metallurgy, or meteorology. The article concludes with the first instalment of a list giving the names of the recipients of the doctorates during 1919–20, together with the titles of their theses.

THE second term at University College, London, begins on Tuesday, January 11. During the term a number of public and other courses of lectures will be given, full particulars of which can be obtained from the Secretary, University College, London, W.C.1. The attention of readers of NATURE may be directed to the following:—Public Lectures: "The Navigation of Aircraft by Astronomical Observations," by Prof. L. N. G. Filon, on Friday, January 14; "Greek Medicine," by Dr. Charles Singer, on Friday, January 28; "Basque Customs," by Prof. J. E. G. de Montmorency, on Thursday, February 24; "The History of Plant Delineation," by Dr. Charles Singer and Dr. Agnes Arber, a course of four weekly lectures commencing on March 2; and "The British Museum in War-time," by Sir Frederic Kenyon, on Friday, March 4. The following courses of lectures will also commence on the dates indicated:—"Fine Art Anatomy," by Prof. G. Elliot Smith, on Monday, January 10; "History of Mathematics up to the Eighteenth Century," by Mr. T. L. Wren, on Tuesday, January 11; "General History and Development of Science," by Dr. A. Wolf (continued from 1st term), on Wednesday, January 12; "Measurements of Stresses in Materials and Structures," by Prof. E. G. Coker, on Monday, January 17; "Mathematical Theory of Relativity," by Dr. G. B. Jeffery (continued from 1st term), on Monday, January 17; "History of the Biological and Medical Sciences from Early Times to the Eighteenth Century," by Dr. Charles Singer (continued from 1st term), on Tuesday, January 18; "The Present State of our Knowledge of the Science of National Eugenics," by Prof. Karl Pearson, on Wednesday, January 19; "Spectroscopy, General and Applied," by Dr. S. Judd Lewis, on Friday, January 21; and "Development of Medicine in Modern Times," by Dr. Charles Singer, on Tuesday, March 8.

Calendar of Scientific Pioneers.

January 7, 1786. Jean Etienne Guettard died.—The discoverer in 1752 of the extinct volcanoes of Auvergne and the compiler with Lavoisier of a mineralogical map of France, Guettard has been called "the father of all the national Geological Surveys."

January 7, 1893. Joseph Stefan died.—Professor of physics at Vienna and director of the Physical Institute, the law of cooling which bears Stefan's name was enunciated by him in 1879.

January 8, 1642. Galileo Galilei died.—The founder of the science of dynamics and one of the greatest of the early experimentalists, Galileo, wrote J. D. Forbes, "was beyond all comparison the glory of his age." Some years older than Kepler, Galileo was born in 1571 at Pisa, where he studied and lectured and made his experiments on falling bodies. The leaning Tower of Pisa now bears the inscription:

GALILEUS GALILEJUS
Experimentis E Summa Hac Turri Super Gravium Corporum
Lapsu Institutis
Legibus Motis Detectis
Mechanicen Condidit
Ingentibusque Suis Posteriorumque Sophorum Inventis
Praelusit

The astronomical discoveries of Galileo were made while he held the chair of mathematics at Padua. In 1609 he heard of the invention of a crude telescope. Seizing upon the idea, he made an instrument to magnify thirty times, and within eighteen months he had observed the mountains and craters of the moon, seen the planets as discs, counted forty stars in the Pleiades, discovered four of the satellites of Jupiter, was perplexed by the curious appearance of Saturn due to the ring-system, observed the gibbous, as well as the crescent, phase of Venus, and had closely followed the spots in the sun. He was then at the zenith of his career. The greater part of his later life was passed at Florence, and to this period belong the controversies and persecutions which embittered his last days.

January 9, 1848. Caroline Lucretia Herschel died.—Returning to England with her brother William in 1772, Caroline Herschel for fifty years was his most patient, skilful, and zealous assistant. The minor planet Lucretia was named after her by Palisa in 1889.

January 10, 1778. Linnæus died.—Carl von Linné or Linnæus was born on May 3, 1707, at Roëshult, Sweden. A student at Lund and a lecturer at Upsala, through much poverty he clung to his first love of botany. An expedition to Lapland was followed by travels in Holland, England, and France. In 1741 he became professor of anatomy and physics in the University of Upsala, but the following year was appointed to the chair of botany. His last edition of his "Systema Naturæ" appeared in 1768.

January 10, 1833. Adrien Marie Legendre died.—The contemporary of Laplace and Lagrange, and the instructor of Cauchy and Arago, Legendre was on the Commission for connecting Greenwich and Paris by triangulation, and made notable additions to various branches of higher mathematics.

January 12, 1665. Pierre de Fermat died.—Born in the province of Gascony, Fermat was trained as a lawyer, and became a councillor of the local Parliament at Toulouse. He was the correspondent of Descartes, Torricelli, Pascal, Huygens, Wallis, and others, and made additions to geometry, the calculus of probabilities, and the theory of numbers.

E. C. S.

Societies and Academies.

LONDON.

Faraday Society, December 13.—Sir Robert Hadfield, Bart., president, in the chair.—Prof. E. D. **Campbell**: A force field dissociation theory of solution applied to some properties of steel. Understanding of the properties of alloys has been obscured by the use of the term "solid solution" and by expressing constitution in terms of percentage weights. There is no essential difference between a liquid and a solid solution, and the constitution of both should be expressed as molecular or atomic concentrations per unit volume. The electrolytic dissociation theory in its usual form is inapplicable to alloys. The force field theory is a modified form of it applicable to liquid and solid solutions alike. The assumption is made that in a molecule the electromagnetic force field associated with the constituent atoms is closed in the combination, but in solution this force field is opened out by the solvent to an extent depending on concentration and composition. The reactivity of ions is due to the open force fields, and not to the presence of electric charges. In the presence of an impressed e.m.f. the resultant of the reactivity is electrical resistance in the case of metallic solutions, and electrical conductance in aqueous solutions.—A. L. **Norbury**: The electrical resistivity of dilute metallic solutions. It is well known that the small quantities of impurities in solid solution cause a large increase in the electrical resistivity of a pure metal. Data are collected showing the relative atomic effects of such impurities, and a certain relationship appears to be brought out by doing so. The author summarises his conclusions as follows:—(1) A comparison with the atomic volumes, intrinsic pressures, electrical resistivities, thermo-electric properties, and decomposition potentials of the elements concerned shows that none of these atomic properties can be directly applied to explain the results. It is suggested that the atomic effects are small when there is little electrical attraction between the atoms of solute and solvent, and large according as the electrical attraction between the two is greater. (2) It seems probable that in the dilute solutions quoted the atoms of solute are not associated. (3) Assuming, for example, the face-centred cube lattice in a dilute solid solution, an atom of solute will be surrounded by twelve equidistant atoms of solvent, and will not be attached to any one of these atoms in particular. It will, therefore, exert attractive forces on the electrons of the surrounding atoms. (4) It is generally assumed that metals conduct the electric current by means of their "free" electrons; the presence, therefore, of forces restraining the "free" electrons in solid solutions will account for their diminished conductivity.

Geological Society, December 15.—Mr. R. D. Oldham, president, in the chair.—Dr. T. O. **Bosworth**: Structure and stratigraphy of the Tertiary deposits in north-western Peru. The westernmost ranges of the Andes in the north of Peru are of pre-Tertiary age. The Tertiary rocks occupy a narrow strip of country between the mountains and the sea, and they consist of 15,000 ft. to 25,000 ft. of clay-shales and sandstones, with thin seams of beach-pebbles and shells. During the Tertiary period a large subsidence was in progress. The stratigraphical succession is:

		Ft.
MIOCENE.	Zorritos Formation	5000+
EOCENE.	Lobitos Formation	5000+
	Negritos Formation.	
	Clavilithes Series / Turritella Series	7000+

The Tertiary accumulation is greatly broken up by intense block-faulting; between the fault-blocks are differential displacements of many thousands of feet. An important movement probably occurred along a great fault-belt parallel with the Andes.—H. **Woods**, Dr. T. W. **Vaughan**, Dr. J. A. **Cushman**, and Prof. H. L. **Hawkins**: Palæontology of the Tertiary deposits in north-western Peru. The fauna of the Negritos formation is of shallow-water gastropods and lamellibranchs, with a small number of teeth of fishes, decapod crustacea, corals, and one Echinoid. Aturia is also present. The number of species is large, and nearly all are new. By the stages reached in the evolution of Venericardia of the Planicosta group correlation is made with the Tejon group of California; but the relation to the Wilcox and Lower Claiborne groups of the Eastern and Gulf States of America is more marked, and is sufficient to indicate the existence of a sea-connection between the Pacific and the Atlantic. The Lobitos formation is distinguished by Foraminifera of the genera Lepidocyclina and Orthophragmina. In the Zorritos formation Miocene age is indicated by the similarity of some of the gastropods and lamellibranchs to those of the Miocene of Panama.—Dr. T. O. **Bosworth**: Geology of the Quaternary period on a part of the Pacific coast of Peru. Throughout the Quaternary period the littoral has undergone a series of vertical oscillations having a hinge-line in the Andes. The ocean-soundings show a steep 2000-ft. submarine cliff at the edge of the continental shelf. This cliff is taken to be a submarine fault-scarp, marking the important fracture (Pacific fault) which was the western boundary of the Quaternary uplifts. The oldest and highest of the raised sea-floors now has an elevation of 1100 ft. It extends 20 miles inland, and, within the territory discussed, covers an area of 700 square miles. The inland boundary of each "tablazo" is a raised sea-cliff. The original western limit of each one of them was probably the edge of the continental shelf. The depth, 27 miles from the present coast, is 12,000 ft. The Quaternary deposits formed upon it are presumably deep-sea oozes. The events on the east side of the Pacific fault are grouped into four similar episodes. Each consists of a subsidence accompanied by marine transgression, followed by an uplift causing emergence of new land. They are: (1) The Mancora, (2) the Talara, (3) the Lobitos, and (4) the Salina episode. Four episodes have left their mark. The most substantial of the deposits formed during these marine transgressions is 250 ft. thick. The material ranges from shell-limestone to beach-pebbles. The shells have been examined by Col. A. J. Peile, who pronounces them (probably all) to be living species. On the land extensive breccia-fans and valley-terraces were produced under desert conditions during these oscillations. It is considered that not one ten-thousandth part of the Quaternary history outlined can have taken place within the last five hundred years.

PARIS.

Academy of Sciences, December 13.—M. Henri Deslandres in the chair.—C. **Guichard**: Networks which comprise a family of geodesics, and such that their reciprocal polar with respect to a linear complex is a network O.—H. **Parenty**: The waves of shock of A. Dévé.—P. **Vuillemin**: The inflorescence of *Fuchsia coccinea*.—A. **Buhl**: Double integrals in which the pseudo-lines at infinity are zero lines.—T. **Varopoulos**: A class of functions with an infinite number of branches.—M. **Takagi**: Bodies resolvable algebraically.—M. **La Porte**: The utilisation of tidal currents on the coasts of France. Instead of holding back the water by a dam, involving costly constructive work, it is proposed to make use of the horizontal current to move a wheel or turbine. A list of suitable channels on the French coast is given, with details of the current velocities.—A. **Danjon**: New determination of the solar period based on the law of luminosity of the eclipses of the moon. By this method the solar period is found to be 10·87 years between 1583 and 1912.—Z. **Klemensiewicz**: Contribution to the theory of thermal radiation.—S. **Posternak**: The hexabasic polymolybdates.—L. **Moret**: The lithological constitution of the Nummulitic and the Upper Cretacean of the Arâche plateau (Platé massif, Haute-Savoie).—L. **Cayeux**: The cause of the high phosphorus content of the Lorraine minerals. Reasons are given for supposing that the high phosphorus content of the Lorraine iron-ore is of organic origin; remains of fishes are exceptionally abundant.—C. **Gorceix**: Traces of man in the Voglans lignites (Savoie). The fall of a roof in the lignite mine exposed a layer of wood-charcoal, considered by the author as caused by human agency.—P. **Glangeaud**: The traces left in the central French massif by the glacial invasions of the Pliocene and Quaternary: the extent and multiplicity of these invasions. To the parts of the central massif on which glacial action has been proved must now be added the mountains Margeride (at the head of the valleys of the Allier and the Truyère) and Lozère, a part of the Hautes Cévennes, and the Velay. Altogether, more than an eighth of the central massif must have disappeared under ice, snow, or névé. The factors which have contributed to the attenuation or effacement of traces of glacial action in this region are discussed.—Mlle. Y. Boisse **de Black** and P. **Marty**: The origin of certain *claux* of Cantal.—C. E. **Brazier**: The measurement of the vertical component of the velocity of the wind with the aid of anemometric vanes. The instrument known as the clino-anemometer has led to the paradoxical conclusion that the air, instead of flowing horizontally, has an average movement at all seasons of the year of a vertical velocity of about 0·5 metre per second. An experimental study of this instrument in the laboratory has shown that the velocity of rotation, instead of being, as previously assumed, proportional to the vertical component of the wind velocity, is proportional to a fraction of this component, which is smaller as the inclination of the wind to the horizon is reduced. The meaning of the older observations is discussed in the light of these new facts.—A. **Piédallu**, P. **Malvezin**, and L. **Grandchamp**: The action of oxygen on the musts of red grapes. The oxygen in these experiments was passed into the liquid in very minute bubbles through the walls of a porous cell. Practically the whole of the red colouring matter was removed by this treatment.—R. **Wurmser** and Mme. J. **Duclaux**: Photosynthesis in the algæ *Chondrus crispus* and *Rhodymenia palmata*.—P. **de Beauchamp**: Biogeographical researches on the zone of tides at the Island of Ré.—M. **Doyon**: The mechanism of the action of morphine on the coagulability of the blood. The effect is not produced *in vitro*. The property of incoagulability is due to the presence of a nucleoprotein secreted by the organism under the action of morphine, and the circulating blood is capable of preventing, *in vitro*, the coagulation of the blood of a normal subject.—S. **Tchahotine**: The method of microscopic radio-puncture: a means of analysis in experimental cytology. The production of a mechanical lesion of a single cell offers great experimental difficulties. In place of this the author acts on the cell with an extremely thin bundle of ultra-violet rays of a diameter not greater than 5μ. Details of the technique are given.—A. **Salimbeni**: The nature of the bacteriophage of d'Herelle.—P. **Séguin**: Culture of the buccal spirochæta favoured by some bacteria.

ROME.

Reale Accademia dei Lincei.—(Communications received during the vacation.)—F. **Bottazzi**: Striated muscles and ligaments of homœothermic animals, xiii. Contraction of striated muscle by cold.—G. **Fano**: Surfaces of the 4th order with infinite discontinuous birational transformation groups, iii.—G. **Fubini**: Contravariant differentials.—M. T. **Ambrosetti**: Projective determination of a congruence W.—U. **Bordoni**: Isentropic transformations of univariant systems.—L. **Stipa**: Projectively applicable surfaces.—A. **Terracini**: Spaces tangential to a given variety, i.—F. **Tricomi**: Expansion of integrals of a differential equation in a series of definite integrals.—W. **Del Regno**: Variations of electric resistance in nickel-steel due to heat, i.—G. **Canneri**: Nitrite of thallium.—R. **Ciusa**: Salts with *o*-, *m*-, and *p*-quinoid structures, ii.—C. **Mazzetti**: Double ternary systems with lacuna of miscibility in liquid and solid states, i.—G. **Rovereto**: Erosive action in continuous, as opposed to cyclic, development.—E. **Carano**: Cyto-embryonic studies in Erigeron.—L. **Beccari**: Action of adrenalin on the heart.—D. **Maestrini**: Studies of enzymes, iv. Emulsin, cytasis, ereptasis, and ureasis of germinating barley.—M. **Boldrini**: Sexual differences in weight of human body and organs, iii.—E. **Federici**: Campaign against Anopheles larvæ by means of aquatic insects, i.—G. **Fano**: Surfaces of the 4th order with birational transformation groups, iv.—G. **Armellini**: Observations on secular comets. The author disagrees with the prevailing opinion that parabolic orbits are necessarily of stellar origin.—A. **Terracini**: Spaces tangential to a given variety, ii.—W. **Del Regno**: Variations of electric resistance in nickel-steel, ii.—C. **Mazzetti**: Double ternary systems, ii.—M. **Padoa**: Specific heats.—P. **Comucci**: Metamorphoses of contact between limestone and granitic porphide in metalliferous deposits of Oroli, in Sardinia.—S. **Sergi**: Intercostal muscles and sexual differences in respiration of the chimpanzee.—G. **Quagliariello**: Proteid and residual nitrogen in serum of blood of vertebrates and invertebrates.—E. **Federici**: Campaign against Anopheles larvæ by aquatic insects, ii. This part deals with the predaceous Coleoptera and Rhynchota. Of these the beetles and water-scorpions appear rarely to select Anopheles larvæ as their prey; on the other hand, water-boatmen are the most voracious destroyers of the mosquito larvæ, and water-measurers also frequently attack them.—L. **Bianchi**: Quadratic character of numbers in a quadratic body.—G. **Fano**: Surfaces of the 4th order with infinite groups, v.—C. **de Stefani**: Siliceous fossil sponges of western Liguria, ii. These sponge remains occur in the Lower Trias at Arenzano in quartzite, in the Middle Trias of Voltaggio, in the Triassic limestone of Spotorno, and in a peculiar Triassic formation at Isoverde.—G. **Armellini**: Determination of latitude of the Capitoline Observatory, i.—E. **Federici**: Campaign against Anopheles larvæ by aquatic insects, iii. After considering the orders Neuroptera and Pseudoneuroptera the author, in summarising, concludes that the method is of very limited efficacy.—M. **Cantone**: Elastic molecular forces and resulting vibrations.—R. **Serini**: Theory of the circular-plate electric condenser, ii.—G. **Armellini**: Latitude of the Capitoline Observatory, ii. The mean values of three series of observations in 1920, viz. 41° 53′ 33·05″, 33·17″, and 33·28″, show the variation of latitude due to shifting of the earth's axis.—U. **Crudeli**: Oscillatory progressive waves of permanent type, second approximation.—I. **Galotti**: "Glandular coupling" in larval stomach of *Rana esculenta*. The organ described under this name by Ruffini in 1899 occurs in the larva of the frog, and was regarded as going to form part of the glandular system of the stomach of the definitive form.—S. **Pastore**: Action of saliva on starch in presence of gastric and pancreatic juices.—O. **Munerati**: Influence of low temperature on germination of freshly gathered corn and other seeds. In confirmation of a result previously found by G. T. Harrington, these experiments showed that at temperatures of about 12° C. more than 90 per cent. of the fresh corn and seeds germinated in a few days, whereas at higher temperatures very few began to grow.—M. **Ascoli** and G. **Izar**: Action of serum of pregnancy on placenta extracts.

Books Received.

Ministry of Finance, Egypt. Survey of Egypt. Meteorological Report for the Year 1914. Pp. xii+242. (Cairo: Government Press.) P.T. 30.

The Place-Names of Northumberland and Durham. By Prof. A. Mawer. Pp. xxxviii+271. (Cambridge: At the University Press.) 20*s*. net.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1921. Pp. 840. (London: H. Greenwood and Co., Ltd.) 2*s*. net.

Scientific Life and Works of H. C. Ørsted. Edited by K. Meyer. (From H. C. Ørsted; Scientific Papers, vol. i.) Pp. clxvi. (Copenhagen: A. F. Høst and Son.)

La Faculté de Médecine de l'Université de Paris. Pp. 84. (Paris: Masson et Cie.) 1 franc.

Technique des Pétroles. By R. Courau. Pp. 406+19 plates. (Paris: O. Doin.) 16 francs.

Elements of Statistics. By Prof. A. L. Bowley. Fourth edition. Pp. xi+459. (London: P. S. King and Son, Ltd.; New York: C. Scribner's Sons.) 24*s*. net.

The Scientists' Reference Book and Diary, 1921. (Manchester: J. Woolley, Sons and Co., Ltd.) 3*s*. 6*d*.

Nedbøriagttagelser i Norge utgit av det Norske Meteorologiske Institut. Aargang XXV., 1919. Pp. xii+80+45. (Kristiania: H. Aschehoug and Co.) 6 kroner.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1919. Pp. xii+173. (Kristiania.)

The Basis of Psychiatry (Psychobiological Medicine). By Dr. A. C. Buckley. Pp. xii+447. (Philadelphia and London: J. B. Lippincott Co.) 30*s*. net.

Autobiography of Andrew Carnegie. Pp. xii+385. (London: Constable and Co., Ltd.) 25*s*. net.

Abnormal Psychology and its Educational Applications. By F. Watts. (Published in its first edition as "Echo Personalities.") Pp. 191. (London: G. Allen and Unwin, Ltd.) 7*s*. 6*d*. net.

Psychology and Psychotherapy. By Dr. W. Brown. Pp. xi+96. (London: E. Arnold.) 8*s*. 6*d*. net.

Macmillan's Historical Atlas of Modern Europe. Edited by Prof. F. J. C. Hearnshaw. Pp. ix+30+xi maps. (London: Macmillan and Co., Ltd.) 6*s*. net.

The Mathematical Theory of Electricity and Magnetism. By Prof. J. H. Jeans. Fourth edition. (Cambridge: At the University Press.) 24*s*. net.

Studies in Minor Folds. By C. E. Decker. Pp. ix+89+3 plates. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1.50 dollars.

L'Idéal Scientifique des Mathématiciens dans l'Antiquité et dans les Temps Modernes. By Prof. P. Boutroux. Pp. 274. (Paris: F. Alcan.) 8 francs net.

The Trees, Shrubs, and Plants of Virgil. By J. Sargeaunt. Pp. vii+149. (Oxford: B. H. Blackwell.) 6*s*. net.

Tenth Report of the Development Commissioners for the Year ended 31st March, 1920. Pp. vii+242. (London: H.M. Stationery Office.) 2s. net.

Meteorological Office. Air Ministry. British Rainfall, 1919. The Fifty-ninth Annual Volume of the British Rainfall Organization. Pp. xxviii+268. (London: H.M. Stationery Office.) 12s. 6d. net.

L'Alimentation et l'Elevage Rationnels du Bétail. (Opinions du Prof. A. Mallèvre.) By J.-E. Lucas. Pp. 466+4. (Paris: Librairie Lefrançois.) 18 francs.

The University of Chicago. Publications of the Yerkes Observatory. Vol. iv., part iii. Parallaxes of Fifty-two Stars. By G. van Biesbroeck and Mrs. H. S. Pettit. Pp. 36. (Chicago: University of Chicago Press; London: Cambridge University Press.) 1.50 dollars net.

Hydro-Electric Survey of India. Vol. ii. Second Report on the Water Power Resources of India. Ascertained during the Season 1919–20. By F. E. Bull and J. W. Meares. Pp. 123. (Calcutta: Government Printing Office.) 1.6 rupees.

Analysa Kvalitativní pro Posluchače (Začátečníky) České University. (Qualitative Analysis for Students (Beginners) of the Bohemian University.) By Prof. Dr. B. Brauner and Dr. J. Křepelka. Pp. 179. (Prague: Československé Lékánické Společnosti.)

Geologists' Association, London. An Index to the Proceedings of the Geologists' Association, vols. xxi.–xxx., 1909–19. Pp. 44. (London: E. Stanford, Ltd.) 5s.

Design and Tradition: A Short Account of the Principles and Historic Development of Architecture and the Applied Arts. By A. Fenn. Pp. xx+376+plates. (London: Chapman and Hall, Ltd.) 30s. net.

The Growth and Shedding of the Antler of the Deer: The Histological Phenomena and their Relation to the Growth of Bone. By W. Macewen. Pp. xvii+109. (Glasgow: Maclehose, Jackson and Co.; London: Macmillan and Co., Ltd.) 10s. 6d. net.

The Principle of Relativity. Original Papers by A. Einstein and H. Minkowski. Translated into English by M. N. Saha and S. N. Bose. Pp. xxiii+186. (Calcutta: University.)

Diary of Societies.

THURSDAY, JANUARY 6.

ROYAL SOCIETY OF ARTS, at 3.—Sir Frederick Bridge: The Cries of London which Children heard in Shakespeare's Time (Juvenile Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Freshwaters (Juvenile Lectures).

PHYSICAL SOCIETY AND OPTICAL SOCIETY'S EXHIBITION (at Imperial College of Science), from 3 to 10.—At 4.—Prof. A. Barr: The Optophone.—At 8.—C. R. Darling: Some Unusual Surface Tension Phenomena.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. Louise McIlroy: The Use of Morphia in Labour.—P. Cole: A Series of 43 Cases of Inoperable Uterine Carcinoma treated by the Cold Cautery Method of Percy.

FRIDAY, JANUARY 7.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Lt.-Col. C. Smith: Life on the Gilgit Frontier (Christmas Lecture).

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—H. G. Pusey: The Indicator: Its Use and Application.

SATURDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Conquest of the Land (Juvenile Lectures).

MONDAY, JANUARY 10.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—A. H. Fuller: The Artificial Production of Ice.

SURVEYORS' INSTITUTION, at 8.—W. W. Jenkinson: The Streets of London before the Great Fire.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. J. B. L. Noel: A Reconnaissance in Persia North of the Elburz.

TUESDAY, JANUARY 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. Arthur Thomson: The Haunts of Life: The Mastery of the Air (Juvenile Lectures).

ROYAL HORTICULTURAL SOCIETY, at 3.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.

INSTITUTE OF INDUSTRIAL ADMINISTRATION (in Central Hall, Westminster), at 7.—W. J. Malden: The Measure of Output in Agriculture.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. Rheinberg: Some New Directions for Photographic Research.—F. C. Toy: A Monochromatic Illuminator of Special Design.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. C. G. Seligman: The Older Palæolithic Age in Egypt.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. Morowoka: The Morbid Conditions of the Choroid Plexus in Mental Disease (Illustrated by Epidiascope).

WEDNESDAY, JANUARY 12.

ROYAL SOCIETY OF ARTS, at 8.—Dr. C. S. Myers: Industrial Fatigue (Aldred Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Capt. S. Bramley-Moore: Recent Developments in Transmission.

THURSDAY, JANUARY 13

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—A. C. Dixon: The Theory of a Thin Elastic Plate, Bounded by Two Circular Arcs and Clamped.—A. S. Eddington: Dr. Sheppard's Method of Reduction of Error by Linear Compounding.—M. Kössler: The Zeros of Analytic Functions.—G. A. Miller: Determination of all the Characteristic Sub-groups of an Abelian Group.—E. A. Milne: A Problem concerning the Maxima of Certain Types of Sums and Integrals.—H. J. Priestley: The Linear Differential Equation of the Second Order.—W. F. Sheppard: Conjugate Sets of Quantities.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Sir William Bragg: Electrons (Kelvin Lecture).

OPTICAL SOCIETY (at Imperial College of Science), at 7.45.—Prof. W. Salomonson: A New Ophthalmoscope.—H. Dennis Taylor: An Anastigmatic Flat Field Telescope and its Application to Prismatic Binoculars.—Inst.-Comdr. T. Y. Baker: A Note on Multiple Reflection.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Informal Meeting for Free Discussion.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. R. Pickard: Variations in the Size of the Physiological Cup, and their Relation to Glaucoma.—B. T. Lang: Scotometry.

CONTENTS.

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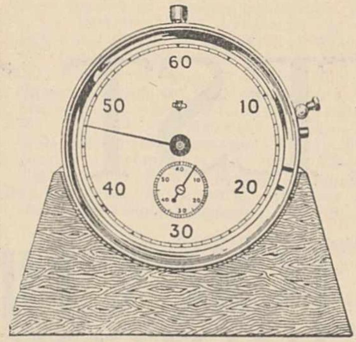

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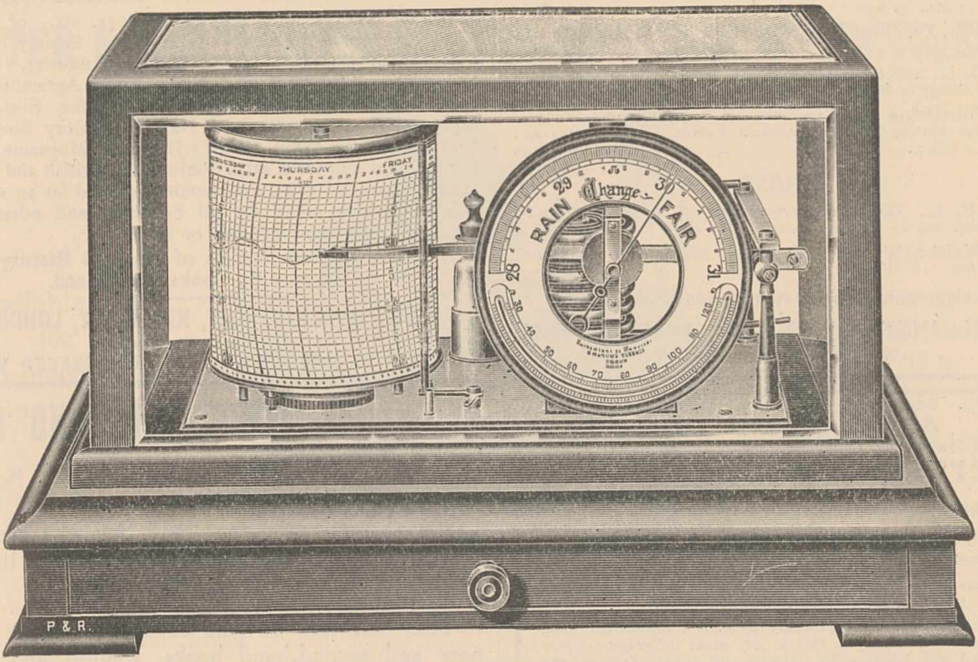

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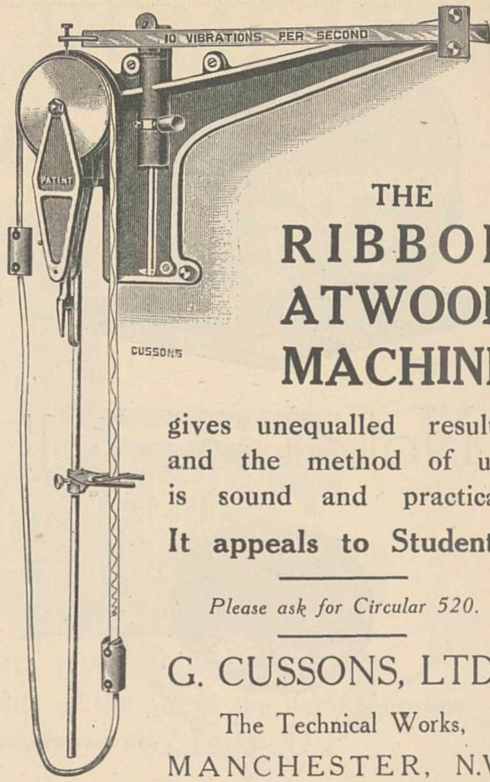

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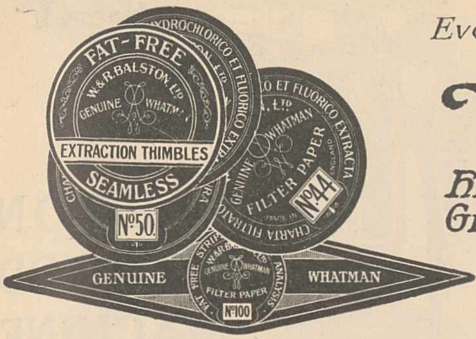

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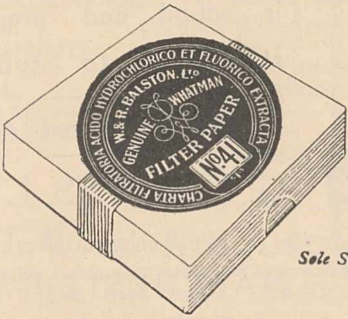

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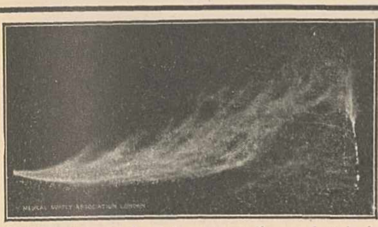

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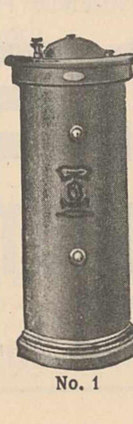

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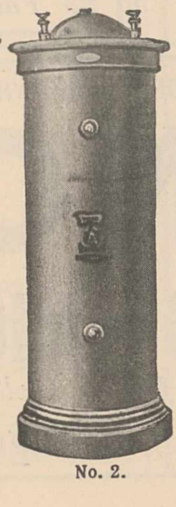

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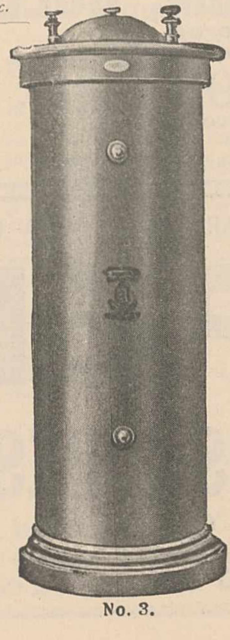

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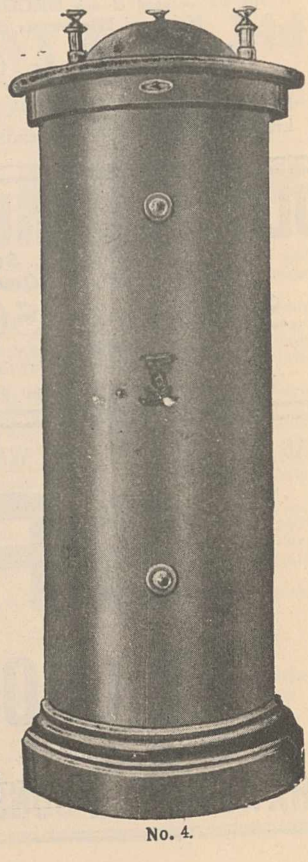

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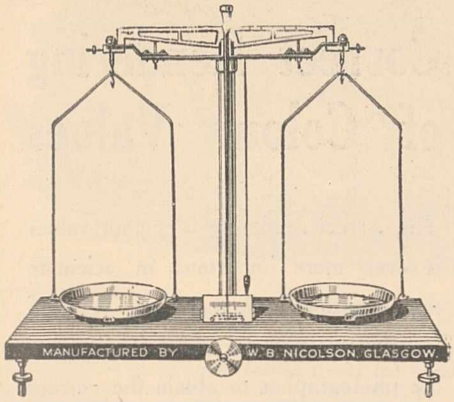

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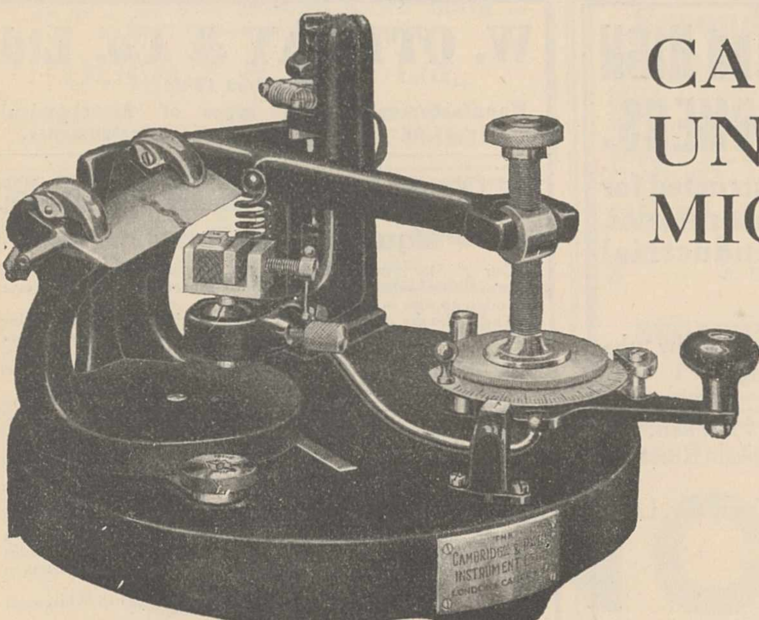

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