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The Site of the University of London.

THE Senate of the University of London will at its next meeting be called upon to make a definite decision regarding the Government's offer of the Bloomsbury site. Mr. Fisher has intimated, and in our opinion not unreasonably, that the offer cannot remain open longer.

The matter has been very fully canvassed during the recess, and the Senate has had leisure and opportunity to consider the issues involved by acceptance or rejection of the Government's offer. For reasons which we have already given, we most earnestly hope that the Senate will decide to adopt the report of its sites committee, which, it is understood, has with certain reservations recommended acceptance of the offer. The discussions of the last few months, so far as they have been relevant, have served only to strengthen our conviction that a refusal will mean the indefinite postponement of a step which is both urgent and necessary for the proper development of the University.

The fact that so much of the discussion has been irrelevant and misinformed is in itself evidence, if evidence were needed, of the failure of the University to impress itself upon the imagination and intelligence of many who are genuinely concerned for higher education in London. Correspondence in the Press has shown beyond doubt that there does not exist any widespread knowledge either of the magnitude of the present activities of the University, or of the nature of its present urgent needs.

The attention which has been given to the suggestion that "The University" should migrate to Hampstead is an illustration. Ken Wood is a delightful spot, and entirely suitable for a residential college or for hostels. But a dozen Ken Woods could not contain the teaching work of the University, and, what is more, they are not wanted. The University of London, or any University of London, must permeate London. Its thousands of students must be distributed, as they are now, throughout London—in the incorporated colleges, in the various "schools" from Kensington to the Mile End Road, in all the great hospitals, and in institutions easily accessible to evening workers. This or some similar arrangement is a necessity for a University of London, and no one building, whether at Hampstead or Bloomsbury or elsewhere, could or should contain the teaching work of the University.

The urgent needs of the University are, we take it, two. They are the provision of suitable administrative headquarters and of a new home for King's College. The need for providing a unifying and co-ordinating centre for the manifold activities of the University is patent. The lack of an adequate home peculiarly and distinctively associated with it has been an obstacle to its progress since its reconstitution. The buildings at South Kensington, dignified though they be, were not designed for their present purpose; they are not suitable for it, nor are they easily accessible. Further, so long as they continue to be known as "The Imperial Institute" rather than "The University," confusion must inevitably persist.

The case is clear for a new building which shall provide accommodation for the administration, for the libraries, for examinations, and for a meeting place where the multitudes of the teachers and students of the University can come together for business and recreation.

The need for a new home for King's College is no less pressing. It has long out-grown the buildings in which it has lived for nearly a century, and its removal to some other site is imperative.

Bloomsbury is indisputably the most convenient quarter both for an administrative centre and for the new home of King's College, and it is the absence of any real alternative to it that is the strongest argument in its favour. The accessibility, the proximity of University College, and of other university organisations, allow and encourage co-operation and obviate the waste of time and the profitless wear-and-tear which are inseparable from the present arrangement.

There remains the question of finance, which we have from the beginning recognised as the really serious question. This has been complicated, unnecessarily we believe, by a comparison of the supposed value of the present King's College site with the Bloomsbury site; but if the former is, as appears to be admitted, inadequate for its purpose, a comparison of site values seems beside the point, and it is surely no derogation to a good bargain that both parties derive benefit from it. The criticism that the Government should continue to be responsible for rates and maintenance charges is of a different kind. Here we think the Senate was on strong ground, and we are glad that it has elicited from Mr. Fisher a statement that these charges will continue to be borne by the Government.

We are glad, too, to see the explicit declaration of the President of the Board of Education that acceptance of the Bloomsbury site will not close the door against building grants from the Treasury. Apart from the technical obstacle to a Government pledging its successors to expenditure for this purpose, it is, we think, apparent that at the present time the Government, faced with demands for economy, might well hesitate to promise unconditionally a large sum for buildings. On the other hand, we are convinced that if the University embarks in earnest upon the provision of a building, neither this nor any future Government could or would withhold its support.

We can only repeat our most earnest hope that the University will decide to accept the Government's offer. The present time may not be the most propitious for embarking upon an appeal for funds, but we are convinced that a courageous policy is the right one, and that the Senate, if it fails to take advantage of the opportunity now offered to it, will have done a serious injury to the future of the University, and lost for many years any claim upon the Government or the public.

Women at Cambridge.

AT Cambridge to-day, October 14, is to be held the official discussion of the proposal to admit women to the membership of the only University in the Empire which gives women no rights. Weeks of somewhat bitter fighting in the Press will follow, and the vote should be taken towards the end of this term or early next term. We will for the moment consider only how the interests of scientific teaching and research are affected by the proposals.

Two reports are to be presented for discussion. Report A proposes a simple statute for adoption, the net result of which is to give women the same opportunities and rights within their own colleges as men have in theirs. They will, as at present, attend the regular courses of teaching in the University and take the University examinations. There will, however, be this difference: success in the examinations will secure for them a degree, as in the case of men students, and women will be able to compete for University prizes, scholarships, and studentships from which they are now debarred. The degree will secure for them in due course, as for men, voting power in the University; at present they receive only the Parliamentary vote for the University member, and a place in a published class list in return for success in the University final examinations. Thus it is proposed that an anomalous and unsatisfactory state of affairs should be ended, and equality of opportunity secured for men and women inside the University. Provision is rightly made in the proposed statute to secure the rights of past students of Girton and Newnham to degrees.

As regards the colleges, the supporters of Report A recognise fully the need to guard against men and women both being members of the same residential college. They therefore propose that the University shall refuse to recognise in any way a woman as a member of a men's college or a man as a member of a women's college. The University has no power to stop a men's college from admitting a woman, but it can see to it that a woman shall gain nothing, so far as the University is concerned, by joining a men's college, and that is what Report A provides for. It should be added that, in this matter, full support is given by the authorities of Girton and Newnham Colleges. The bogey of the mixed college is conjured up only by the supporters of Report B in the hope of securing votes for their scheme. At any rate, they suggest no steps to guard against it.

By the alternative scheme proposed in Report B, the University is to give its blessing to the foundation of a women's University at Cambridge, and to express a desire to continue to afford to students of the new University the privileges as regards instruction, examination, and access to libraries, museums, and laboratories which are at present accorded to students of Girton and Newnham Colleges. This gives the women their degrees, not of Cambridge University, but of a new University at Cambridge. There are arguments on both sides on this point based on sentiment. One real grievance, at any rate, is partly met. No guarantee is, however, offered that existing facilities generally given to women will be continued. They are now admitted to laboratories and lectures only by the courtesy of professors and other teachers. Cambridge is at present suffering from severe pressure on its accommodation. Under Report B women might well be crowded out from laboratories to make room for members of the University—this is fully recognised by the supporters of Report B; that is to say, the report amounts to a desire to assist in the teaching of women so long as the number of men students leaves room for them and no longer. It is no wonder that the councils of the women's colleges at Cambridge have emphatically repudiated such a scheme, and have declared that if Report B is adopted at Cambridge they would take no steps to promote the incorporation of Girton and Newnham Colleges as a separate University. It is no longer possible, in our view, for a university, in sorting out its excess applicants for entry, to take sex as the first and supreme test: intellect and the needs of the nation are both safer tests in the interest of the university and of learning.

One more point in which Report B singularly fails to make good the claims of its supporters may be briefly mentioned. As regards the admission of women to the men's colleges, and through the colleges to the University, it leaves the door wide open as it has stood since the Sex Disability (Removal) Act. It is Report A, and not Report B, which takes safeguards against what is admitted on all sides to be undesirable. It is Report A which, with this precaution, gives women the fullest equality of opportunity with men inside the University.

Lunar Tables.

Tables of the Motion of the Moon. By Prof. Ernest W. Brown, with the assistance of Henry B. Hedrick. Sections i. and ii., pp. xiii +140+39; section iii., pp. 223; sections iv., v., vi., pp. 99+56+102. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1919.) Price, 3 vols., 4 guineas net.

THE appearance of Prof. E. W. Brown's lunar tables marks the accomplishment of an arduous task of the highest importance to astronomy. In the two centuries which have elapsed since the time of Newton more than a score of tables have been published. The majority of them naturally belong to the eighteenth century, and no longer possess any practical interest apart from the theories on which they were based. If they did not always mark any very distinct advance in accuracy beyond their predecessors, they generally aimed at including a greater number of inequalities more precisely determined, and systematic observation of the moon was all the time accumulating the material which could be used for comparison with theory and the better determination of the fundamental constants. Newton himself discussed eight lunar inequalities. Euler in his memoir of 1772 included twenty-one inequalities each in the longitude and the radius vector and sixteen in the latitude. This was only a beginning. As time went on and the standard of achievement grew more exacting it is not surprising to find that the number of men who possessed both the ability and the patient energy to elaborate complete and independent theories of the moon's motion and to reduce them to the form of practical tables became notably smaller. Thus when Burckhardt's tables of 1812 had once been adopted in such annual publications as the Nautical Almanac, overcoming the rival claims first of Bürg and later of Damoiseau, they continued in use for the best part of half a century, although their deficiencies ultimately amounted almost to a scandal, and their form rendered it particularly difficult to reconstruct the underlying theory and to apply the needful corrections. A serious error in the parallax according to these tables was found and corrected by Adams.

The Greenwich lunar reductions undertaken by Airy, by which the results of eighty years' observations were made available, proved the need for greatly improved tables, and provided the most valuable material on this side for making an advance. By that time it was known that Hansen was engaged in lunar researches having for their ultimate object the preparation of entirely new tables, and their appearance was eagerly awaited. But for a time difficulties threatened to intervene. Born in Schleswig in 1795, Hansen is an outstanding example of that singularly rare class, the self-taught mathematician. Owing nothing to academic education, he succeeded Encke in 1825 in the direction of the observatory at Gotha, and thereafter until the end of his long life refused all offers of preferment, though observatory and stipend were alike of the most modest. In these circumstances he received help from the Danish Government, but when this was discontinued in 1848 owing to financial stringency and the steady progress of the work was in danger, the British Admiralty came to the rescue on the representation of Airy in 1850, and not only provided the comparatively small sum needed to complete the work, but also undertook the expense of printing the tables, which accordingly were ready for distribution in 1857. As his earliest researches on the subject were published in 1829, it may be taken that the work filled the main part of Hansen's life for a period of about thirty years.

No excuse is needed for recalling these circumstances at the moment, sixty years later, when Hansen's tables are on the point of being finally superseded. They are not faultless, it is true, and for many years past certain corrections introduced by Newcomb have been adopted in the national ephemerides. But, on the whole, they have served the practical needs of two generations admirably. In Hansen's theory, on which the tables are based, the number of periodic terms had grown to about three hundred. Those which depend on the solar action were for the most part well determined, but those which arise from planetary action were neither complete nor accurate. It is but fair to remember, however, that in previous tables the latter class of terms had been ignored altogether. Considered purely as tables in the technical sense, Hansen's possess acknowledged merits. As a practical computer himself, he had the advantage of great experience and exceptional natural gifts. It is said that in a matter of four-figure logarithms he rarely had need to refer to the tables.

But during the later stages of his researches Hansen was not the only worker on the large scale in the field of lunar theory. Some ten years earlier Delaunay had begun the construction of a theory in purely algebraic form by an original method of integration, and by 1867 that part which depends on the direct action of the sun had been completed and published. His intention had been to add those complementary parts which still remained necessary and to proceed to the reduction of the whole to a numerical and tabular form. This was not to be. Historical events supervened and delayed the progress of the work. Then in 1872 he lost his life by drowning, and his life's work, which had always been pursued without assistance, came to an untimely end. Yet his projects were destined to be accomplished by other hands. The planetary inequalities were calculated by Radau in an admirable memoir, and under his direction the reduction of Delaunay's theory to tabular form was completed before the death of Radau in 1911. From 1915 the lunar ephemeris in the "Connaissance des Temps" is based on these tables. Prof. Brown remarks justly that the value of the purely algebraic development is not seen at its best in the numerical form, owing to the slow convergence of certain classes of coefficients. He also criticises the form of the tables, but this is a matter which will chiefly concern the French computer, and need not affect our appreciation of an independent lunar ephemeris. The value of Delaunay's method is not confined to his own application of it to the lunar theory. But even this can be no ordinary work, which, executed within a few years of Hansen's, assumes a new vitality after lying dormant for half a century.

The new tables of Prof. Brown will be used for the first time in the Almanacs of 1923, and a confident hope may be expressed that they will continue in use for a very long time to come. They are the final outcome of thirty years' work, and, long as this time is, Prof. Brown is to be congratulated equally on the rapidity and on the thoroughness of his labours. For the number of terms now included falls little short of 1500, and, so far as can be now seen, the expression of the effects of purely gravitational action cannot profitably be pushed further. All this work, which is completely new from the beginning, was not contemplated as an integral plan from the start, but grew by successive stages, as Prof. Brown tells us, out of a suggestion by Sir G. H. Darwin to make a study of Hill's papers. The preparation of the theory, which was published in the Memoirs of the Royal Astronomical Society, was finished in 1908, and the liberality of Yale University in undertaking the whole cost of the tables made it possible to proceed with plans for the final stage without delay and without anxiety. Thus the author has been spared some of the cares which fell to the lot of Hansen. None the less, the British Admiralty has once again played a small part in the matter, though in a different way. With proofs and MS. continually crossing the Atlantic during the war, it is recorded that only one set of returning proofs was lost.

It is unnecessary to recall the details of the author's theory. Hill, to whom its foundations are very largely due, was, like Hansen, a practised computer. Though his researches in this field have incidentally enriched celestial mechanics, and even mathematics in general, with new and fertile conceptions, his motive was essentially a practical one. It was to find a path which would lead to the highest possible accuracy in the final results with the greatest economy of labour. The soundness of his ideas can be properly tested and appreciated at no stage short of the fulfilment which Prof. Brown has given to them in this great work. There can be no doubt not only that Prof. Brown has accomplished a worthy and most valuable task, but that he has also with equal judgment employed in the course of it the best available methods.

Sections ii.–vi. contain tabular matter exclusively. The explanation of the tables is contained in the ten chapters of section i. This appears to be a model of clearness. Except in chronological questions and in special researches the ordinary astronomer rarely has occasion for single places of the moon outside the range of the hourly ephemeris provided in the Almanacs. The chief function of the tables therefore lies in the calculation of this ephemeris from year to year, and this fact has been kept in view in their arrangement. Advantage has been taken of Hansen's example to the extent deemed profitable, and a number of original devices have been introduced, including a new scheme of re-entrant arguments. By these means it is believed that the computation of an ephemeris will be at least as rapid as with Hansen's tables, in spite of the inclusion of about five times as many terms. An accumulation of errors in the sums of many tabular entries is unavoidable. From this source probable errors of $0{\cdot}04''$ in the longitude or latitude, and of $0{\cdot}003''$ in the parallax, are expected after these co-ordinates have been finally contracted to one decimal place less. Imperfections in the adopted constants and cumulative small defects of theory may raise these amounts to $\pm 0{\cdot}1''$ and $\pm 0{\cdot}05''$ respectively. Clear instructions are given for making such adjustments in the fundamental constants as may hereafter prove necessary. But there need be no illusion that the moon will actually follow the strict gravitational path laid down so carefully in these tables. As it is, the empirical term

$$+10{\cdot}71'' \sin\{140{\cdot}0^\circ(t_c - 18{\cdot}5) + 170{\cdot}7^\circ\},$$

with a period of 257 years, has been admitted in the longitude, with consequential changes in the arguments of some other terms. In magnitude this is comparable with the great Venus term, and the explanation of it is still to seek. Discrepancies will recur, and the advantage to be expected from the new tables is that they will no longer be entangled with the errors of a faulty ephemeris. If this hope is realised—and there is no reason to doubt that it will be—unstinted gratitude will be due to Prof. Brown and to those who have assisted him either by active collaboration or by financial aid.

The tables have been printed in England at the Cambridge University Press. The paper is of an unusually sumptuous and durable quality appropriate to a work of lasting value which will have to bear repeated handling for a long time. The type is admirably clear. Only one superficial point suggests adverse comment. The pagination is peculiar. In their present form the tables consist of six sections in three volumes. Each section, of length varying from 39 to 223 pages, is paged independently from 1 onwards. In whatever form the work is finally bound, this will surely prove an inconvenient plan for any purpose, such as the correction of errata. A continuous sequence would have been preferable. But perhaps there will be no errata (beyond one already noted), and in any case the blemish, if it be one, is trivial.

H. C. P.

Genesis, Evolution, and History.

The Evolution of the Earth and Its Inhabitants. By Joseph Barrell and Others. A Series of Lectures delivered before the Yale Chapter of the Sigma Xi during the Academic Year 1916–1917. Pp. xiv+208+iv plates. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1918.) Price 10*s*. 6*d*. net.

THIS book consists of five lectures by five experts, who deal with various aspects of evolution. The range extends from the nebula to modern civilisation, and the wonder grows that one word can cover it all. We feel as if the word "evolution" were in danger of becoming like a household knife—used in so many ways that it tends to become useless. The use of the same term for so many different kinds of becoming is apt to suggest that they are all describable by the same formulæ. To avoid this fallacy, might it not be well to find differentiated terms, such as *genesis* in the domain of things, *evolution* in the realm of organisms (keeping *development* for the becoming of the individual), and *history* for the kingdom of man?

The first lecture deals with the genesis of the earth and of the parent solar system, and, the establishment of the earth having been accounted for, its subsequent changes are traced until the time of its becoming a fit home for life. Prof. Barrell adopts the theory of the origin of the earth as a secondary spiral nebula heaved off from the central sun as the result of tidal forces produced by the close approach and passage of another star. He favours the hypothesis of earth-growth by the rapid infall of planetoids (not by Chamberlin's "slow accretion of planetesimals") and the hypothesis of an earth initially molten.

The second lecture, by Prof. Schuchert, discusses the changes of the earth's surface and climate during geologic time, which the author is inclined to put at about 800 million years. The constant shrinkage of the earth leads to an instability of surface that brings about periodic changes, not only in the areal space-relations of water and land, but also in the shapes and heights of the lands. As the lands are elevated, the weathering becomes more active and the high places are brought down to the sea. The waters are thus to a certain extent displaced, and periodically flood more or less of the lands. Every now and then, when the lands are largest, highest, and driest, a cold period sets in and disarranges the whole organic world. During these critical times the earth is scenically grand, and the struggle for existence unusually intense. The over-specialised types give place to smaller, less specialised, more plastic types. The unadaptive types become extinct, or are pressed into corners and refuges. Some adaptive stocks find relatively easy haunts, as in the sea, but from such there evolves no great mentality. The highest organisms, with the greatest mentality, have evolved on the land, "where the struggle for existence is fiercest, because of the constant necessity of adaptation to an environment subject to intense changes. Organic supremacy is attained only through constant vigilance."

In the third lecture Prof. L. L. Woodruff gives a clear and critical account of the various suggestions that have been made in regard to the origin of organisms, cautiously favouring the uniformitarian idea that they arose from not-living matter upon the earth.

Of great interest is the fourth lecture, in which Prof. R. S. Lull discourses on "the pulse of life," attempting to link up cause and effect; "to find those forces which are responsible for the more or less rhythmic accelerations of evolution shown by the fossil record. The main cause is found to be climatic change, which in turn has as a chief controlling factor earth-shrinkage and the consequent warping of the crust." In a very fresh and suggestive way, Prof. Lull discusses some of the crises in organic evolution and their physical correlates. Thus he deals with the establishment of the lime-secreting habit, the origin of vertebrates, the emergence of terrestrial vertebrates, the evolution of the terrestrial foot, the origin of reptiles, the establishment of warm-bloodedness, the appearance of birds and mammals, man's arboreal apprenticeship, his descent from the trees, and his subsequent ascent far above the level of climbing. He submits a very striking curve to show the correspondence between the pulse of life and the heavings of the earth's broad breast. To mention a concrete factor, he shows how *aridity* probably affected the evolution of dinosaurs.

In the fifth lecture Dr. Ellsworth Huntington deals with the influence of climate on civilisation. Human progress depends, he says, upon three resources, and constitutional energy. But climate has a great influence on each of these, especially the last—a thesis which the lecture graphically illustrates. Some of the great steps in civilisation are discussed, and likewise some of the relatively recent climatic changes; the problem is to correlate the two. The author admits that, so far as inherent mental capacity is concerned, climate is in one sense a minor factor; that it is more important as regards material resources, but is far from being the sole factor; and that even when energy is considered, the effect of climate may readily be neutralised by several other factors, such as lack of resources or lack of ability. But the point to be emphasised is that climate is one of the great factors which must be reckoned with in any attempt to understand the history of civilisation.

The five essays are at a high level, the authors evidently giving of their best. There are a number of vivid illustrations, and Prof. Lull's "pulse of life" diagram makes a deep impression. We strongly recommend the book to serious students as a notable contribution to the study of the various modes of the great process of becoming.

J. A. T.

Fertilisers and Parasiticides.

Chemical Fertilisers and Parasiticides. By S. Hoare Collins. (Industrial Chemistry.) Pp. xii+273. (London: Baillière, Tindall, and Cox, 1920.) Price 10*s*. 6*d*. net.

MR. COLLINS has followed up his book on plant products by another on chemical fertilisers and parasiticides, of approximately the same size and intended for the same kind of reader. The book gives a good general account of fertilisers, and it includes numerous tables of data which will be found useful to the specialist.

Artificial fertilisers are of great interest to British chemists, as they were first used in this country and for many years the industry remained in British hands. The beginning was made in 1843, when Lawes took out his first patent for the manufacture of superphosphate; the industry developed greatly when the Chilean deposits of nitrate of soda began to be worked largely by British enterprise, and when sulphate of ammonia was recovered from coal-gas and from coke-ovens. It underwent further expansion in the 'eighties, when Wrightson showed the value of basic slag, followed in the 'nineties by the demonstrations of Dobbie, Gilchrist, Somerville, and Middleton. Only one important section has remained outside British hands—the potash fertilisers, which were formerly controlled by German interests, but now will be worked by the French companies.

Mr. Collins deals mainly with the sources and methods of manufacture of fertilisers and only incidentally with their use on the farm, giving simply such information as the ordinary salesman would need. Liberal use is made of the Rothamsted data, which supply the best demonstrations of the value of the nitrogenous and potassic fertilisers and of superphosphate. Cockle Park, Northumberland, gives the best demonstration of the value of basic slag.

Striking data are shown as to the improvement in the soil effected by the use of fertilisers. Thus at Cockle Park basic slag not only increases the yield of herbage for hay or for grazing, but also leads to an increase in the percentage of nitrogen in the soil—the result of an increased development of clover. After eleven years' treatment with basic slag the percentage of nitrogen in the soil of Tree Field, Cockle Park, has increased from 0·185 per cent. to 0·236 per cent., a gain of about 850 lb. per acre. Neither sulphate of ammonia nor nitrate of soda brought about an appreciable increase in nitrogen content.

A good but short description is given of the deposits of nitrate of soda in Chile, and also of the deposits of nitrate of potash in India. The manufacture of sulphate of ammonia is described, and the account brought up to date by reference to some of the more recent processes. In view of the importance of this industry we should have liked to see a fuller classification of methods and descriptions of typical direct, semi-direct, and indirect processes: the average student of agricultural chemistry has usually no access to modern books in which these are described. An account is given of the Haber process, which will prove of interest now that the method is to be worked in this country.

Superphosphate naturally occupies considerable space, and a useful table shows the composition of the natural phosphates used as raw material. Here, too (as in the case of sulphate of ammonia), one would have liked more information from the works: more might have been told of the different types of dens in use in this country and, before the war, in Belgium. The introduction of electrical power has resulted in certain modifications in methods.

In discussing compound fertilisers no reference is made to the "base"—an organic material often acidulated, or a seed meal—used to obtain proper condition.

From the laboratory side, however, the book is very good, as would have been expected from the author, and as it has no English competitor a good reception should be assured. It contains much useful information that the student could not readily obtain elsewhere.

Lectures on Folk-lore.

Psychology and Folk-lore. By Dr. R. R. Marett. Pp. ix+275. (London: Methuen and Co., Ltd., 1920.) Price 7s. 6d. net.

CONTROVERSY is commonly interesting, if only for the fact that it appeals to a man's pugnacious instincts; and most readers like to be invited to take sides. Eight of the eleven papers in this book were originally lectures, and in most of them Dr. Marett argues vigorously against what he regards as a lifeless manner of attacking the problems of folk-lore. He states his position in the first paper, and stands by it staunchly all through the volume. To him it is perfectly clear that every scrap of folk material is ultimately due to the more or less primitive reactions of the individual mind. Now nobody can understand either the productions or the modes of operation of the human spirit, he believes, by merely looking at them from the outside. The prime problem of all folk-lore is to enter into a man's thoughts, fancies, and emotions when he is confronted by certain definable situations. But simply to study objectively the changes which folk material has undergone in the course of its history is only to gather together a lot of dry bones. The psychologist is needed to put flesh on them, and to breathe into them the breath of life. Dr. W. H. R. Rivers is thereupon, in the most pleasant manner possible, held up as an awful example of the soulless sociologist.

As to this some comments may be made. First, bones *are* needed to make a man, after all. Secondly, the distinction which Dr. Rivers has made, and quite consistently observed, between psychology and sociology is one framed specifically in the interests of method and of clear definition. It is preposterous even to hint that Dr. Rivers has urged that an objective, sociological study can cover anything like all of the ground of interest of folk-lore. He has shown, both by his words and also by his example, that the studies of psychology and sociology must proceed side by side. But he has all along been concerned to utter a much-needed protest against the fashion of mixing up psychological, sociological, biological, and ethical modes of explanation in the customary haphazard manner.

It is very interesting to consider precisely what, in Dr. Marett's opinion, psychology really has to say at present concerning the problems he discusses. The main subjects of his consideration are: War and Savagery; Primitive Values; The Psychology of Culture Contact; The Transvaluation of Culture; Origin and Validity in Religion; Magic or Religion; The Primitive Medicine-Man;

and Progress in Prehistoric Times. Much of what he has to say has a metaphysical or an ethical import, and much is in the way of kindly comment upon fellow anthropologists. If, however, we search for the psychology, we find absolutely no new principle discovered, no new method of analysis proposed, nothing that definitely "sticks in the mind" as marking a clear advance. We are told in many graceful ways that the folk-lorist is to account for his materials "in terms of a self-active, self-unfolding soul"; we learn that man's emotional nature remains relatively stable, though historical conditions constantly change; that religion is a way of life, and not a set of propositions offering themselves to belief; and that suggestibility is peculiarly effective in the primitive community. In many ways the most interesting paper is the brief one on "The Transvaluation of Culture." Here a real attempt is made to analyse the forms of transference of folk materials which commonly occur as a result of the interplay of cultures. The analysis is extremely interesting, but not sufficiently developed, and this criticism applies to the whole book.

In the final paper on "Anthropology and University Education" Dr. Marett says many good things well.

The book is most pleasing to read throughout, for it could scarcely be better written. Yet it is disappointing. It is too vague and too general. Modern psychology can do more for folk-lore than Dr. Marett makes clear, and at the same time it has everything to gain and nothing to lose by a clear recognition of the equal value and necessity of an objective, sociological method of approach.

F. C. BARTLETT.

Elementary Chemistry.

(1) *Intermediate Text-book of Chemistry.* By Alexander Smith. Pp. vi+520. (London: G. Bell and Sons, Ltd., 1920.) Price 8*s*. 6*d*. net.

(2) *College Text-book of Chemistry.* By William A. Noyes. Pp. viii+370. (New York: Henry Holt and Co., 1919.)

THE above titles may be misleading to English readers, the ground covered by each book being practically of Matriculation standard. The authors have, however, conveyed in addition interesting information not usually found in English text-books of similar character. The chemistry of common life and of industry receives brief treatment, and these elementary books should prove interesting to the advanced English student who, in preparing for examinations, has attained detailed knowledge of such matters as the syntheses of alkaloids and other things he is never likely to see, but has been left in ignorance of chemical processes in the body, the growth of plants, the manufacture of such things as glue, ink, bread, candles, and soap, and most of the applications of chemistry to daily life.

(1) The fundamentals of chemical theory receive careful consideration in both books; that of Prof. Smith treats in detail of the theory of electrolytic dissociation and its applications. Exception might be taken to the treatment of Avogadro's law and its relation to atomic weights. This is dealt with in the same way by both authors. The molecular weight is defined as the weight of a gaseous substance filling a volume of 22·40 litres at S.T.P., and the atomic weight of an element as the least weight found in this volume of any one of its gaseous compounds. No reason is given when the definitions are stated as to why 22·40 litres has been chosen, and it is only in the case of ideal gases that the definitions are valid. This method leads Prof. Smith to say, for instance, when describing hydrogen chloride (p. 123): "The density of the gas (weight of 1 c.c.) is 0·001628. Of more interest to the chemist is the weight of 22,400 c.c. or 22·4 liters (the gram-molecular volume), namely, 36·468 grams. This is the molecular weight of the substance. As we have seen (p. 77), it is made up of 1·008 g. of hydrogen combined with 35·46 g. of chlorine." This statement, if taken literally, is incorrect. If it is not to be taken literally, why should three places of decimals be given?

Although Scheele was the first to discover oxygen, the claims of Priestley as an independent discoverer have not so far been questioned. We now learn from Prof. Smith that Priestley is "incorrectly credited with the 'discovery' of the element," and that he described the gas as "unbreathable and noxious (poisonous)." In reality, Priestley breathed the gas himself, and recommended its use in pneumonia. The statement on the same page that oxygen was discovered by Bayen in April, 1774, is another piece of historical inaccuracy. The memoir of Bayen to which reference is doubtless made (*cf.* "Opuscules," vol. i., 1798) contains no indication that this experimenter knew that the "air" given off on heating mercuric oxide differs from common air (*ibid.*, pp. 252, 312, and the editor's introduction), which is the real point at issue. Equally unfortunate is the statement that the law of conservation of energy is due to "J. R. Mayer (1842), Colding (1843), and Helmholtz (1847)," without a mention of Joule!

It seems a pity that such spelling as "woolen," "mantel," "ladeled," "marvelous," and "sulfur" should minimise the value of a text-book to English students in schools, where the rest of the curriculum has to be kept in mind by the teacher.

(2) Prof. Noyes's text-book is particularly interesting and suggestive, and very well got up, with the exception of the illustrations. The treatment is in general more concise than in the other volume, but loses nothing in the way of clearness and accuracy. It should prove a useful book to teachers in the higher forms of schools who wish to add to the interest of their lessons. The summaries at the ends of the chapters will be found useful in revision, and there are numerous suggestive questions and exercises. The elements of organic chemistry, in so far as they concern daily life, are treated in a most interesting manner, and the book should prove serviceable to students of domestic science.

It may fairly be said of both books that they are of a higher order of interest and accuracy than is usual in English books of the same standard. There is too much tendency to follow stereotyped lines in most cases in English books, which no doubt results from a desire on the part of the writers to conform to what they imagine to be useful for examinational purposes. The American writers as a whole are free from this infirmity.

J. R. P.

Our Bookshelf.

Moses: The Founder of Preventive Medicine. By Capt. Percival Wood. (Biblical Studies.) Pp. xi+116. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) Price 4*s.* net.

Capt. Percival Wood is, of course, not the first to recognise Moses as the founder of preventive medicine, but he has marshalled his evidence in an interesting and compelling manner in the light of modern research. Thus he ascribes the third plague that smote the Egyptians, that of lice, as the indirect result of the first plague of fouled water-supply, remarking that it does not take long in a warm climate to become infested with lice when personal hygiene is neglected. The frogs, similarly, were driven on to the land by the fouling of the water, and the myriads of dead frogs tended to breed the flies of the fourth plague. The lice and the flies and the rain, together with the destruction of their crops by locusts and hail, would likewise tend to engender epidemic disease among the famine-stricken Egyptians, and hence the culminating plague of all, that of death (the selection of the firstborn in the narrative is a dramatic detail added by a later hand).

The author passes in review the legislation on hygiene and on the control of infectious diseases, and the regulations regarding dietetics. Finally, the diet of the Israelites during their wanderings is considered. The nature of manna is problematical. There was evidently a lack of proper food, and the people probably suffered from deficiency diseases—dwarfs, "broken-footed," and "crookbacks" are mentioned, conditions that might result from rickets. As a popular and accurate description of an ancient system of hygiene this book can be cordially recommended.

R. T. H.

Structural and Field Geology: For Students of Pure and Applied Science. By Dr. James Geikie. Fourth edition, revised. Pp. xxiv+454+lxix plates. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1920.) Price 24*s.* net.

The demand for a fourth edition of this handsome work is sufficient testimony to its educational value. The volume reflects the lucid teaching of its author, and the present editor, Dr. Robert Campbell, has found it desirable to make alterations only in definitions and in descriptions of minerals and rocks, in accordance with current usage. Chemical formulæ, which are so useful in suggesting alliances among rock-forming minerals, are still studiously avoided, except in the case of simple oxides. This is surely now unnecessary, when some knowledge of chemistry must be required of all students of a scientific subject. Though Dr. James Geikie expressly stated that he did not write for specialists, a very little more would have held the interest of the reader.

The great aim of the book, however, is the realisation that rocks are to be studied out of doors, and that structural geology is based upon what the earth itself reveals. The selection of full-page photographic illustrations, from those of mountain-crests like Goat Fell to those of rock-surfaces as they actually are seen in Nature, calls us urgently to the field. Contrast the majestic gloom of the Torridonian and Cambrian masses in Plate lxviii with the sunlit and periwinkled rocks on the Arran shore in Plate xliii, and you perceive the artist in the field-surveyor. It is a compliment to the publishers, as well as to the memory of the author, to say that this is a gift-book of a high attraction.

G. A. J. C.

Notes Pratiques sur l'Observation Visuelle des Etoiles Variables. Par Maurice E. J. Gheury de Bray. Extrait de *Ciel et Terre.* (Published by the Author: 40 Westmount Road, Eltham, S.E.9.) Price 2*s.* 4*d.* post free.

The careful and persistent observation of variable stars has risen from being the occasional hobby of a few observers to one of the most important branches of stellar physics, from which far-reaching deductions have been drawn concerning star-life, absolute magnitudes, and the structure of the universe. The number of variables is now so large that a considerable army of workers is required. The author's aim is to enlist recruits, and the field of work that he recommends is that of the long-period variables of large light-range, since visual estimates of light-difference are sufficient in these, while the Cepheids and eclipse-variables call for more refined methods and more highly trained observers. The use of charts for identifying the variable and comparison stars is explained, also the "fraction" and "step" methods of estimating light-intervals, the drawing of the light-curve, and the deduction of the epochs of maximum and minimum. The amateur who contemplates extensive work in this field is wisely recommended to join the variable star section of the British Astronomical Association; its director makes a selection of the stars needing observation, and divides the work among its members.

The physical explanation of variation lies outside the scope of the little book, but something is said about the resemblance between light-curves and the curve of sun-spot activity.

It may be noted that the author, though he writes in French, has been resident in England for many years, and is a lecturer at the Woolwich Polytechnic.

Military Psychiatry in Peace and War. By Dr. C. Stanford Read. Pp. vii+168. (London: H. K. Lewis and Co., Ltd., 1920.) Price 10*s*. 6*d*. net.

THIS very interesting and valuable work deals with the mental disorders encountered in the Army in peace and war. The author was, until the time of the armistice, in charge of D block at Netley, a clearing hospital through which passed practically all the mental cases arising in the various theatres of war. He has made every use of his very exceptional opportunities, not only carrying out careful observations and records of the 3000 cases which passed through his hands, but also following up the later history of these cases after their transfer from Netley to other hospitals.

Detailed descriptions of the various forms of mental disorder are given, together with statistical facts and charts illustrating their frequency and incidence; and the military organisation developed during the war to deal with the sufferers from mental disease is interestingly described. The author belongs to the school which believes that mental disorders are essentially biogenetic, and that they are the result of a failure on the part of the organism to adapt itself to the environment in which it has to live. In this failure of adaptation an essential part is played by psychological factors, and throughout the book emphasis is laid upon their importance. A preliminary chapter on the psychology of the soldier deals with the various mental forces the action and interaction of which may lead to the outbreak of disorder.

The book is essentially a medical work, and can scarcely be recommended to those without technical knowledge of the subject, but it should prove of the utmost value to the psychiatrist, and constitutes a noteworthy addition to the medical library of the war.

Wasp Studies Afield. By P. Rau and Nellie Rau. Pp. xv+372. (Princeton: University Press; London: Oxford University Press, 1918.) Price 8*s*. 6*d*. net.

To those surveying the boundary between instinct and reason there is no more fruitful field than the fossorial wasps, with which this book is chiefly concerned. The greater part of Mr. and Mrs. Rau's illuminating volume is descriptive of the actions of individuals; but the last chapter is an impartial judicial summary, from which we extract the following items:—(1) There are very definite and ironclad instincts. (2) Despite these instincts, which are constant in each species, there is much variation in the behaviour of the individuals. (3) There is a display of the expression of emotions. (4) There is much aptitude for learning, display of memory, profiting by experience, and what seems to us rational conduct. No reader of these pages can deny that these conclusions are abundantly justified by the facts narrated.

The most complete portion of the present work is the careful series of experiments on the "homing" of the social wasp *Polistes pallipes*. These prove beyond question that "homing" is no special faculty, but depends entirely upon experience and associative memory of surrounding objects.

A few misprints, *e.g.* "most" for "moist," p. 347, "fililng" for "filling," p. 363, and the omission of a whole line after l. 8, p. 365, require attention if further editions of this otherwise admirable work are contemplated. O. H. L.

Internal-Combustion Engines: Their Principles and Application to Automobile, Aircraft, and Marine Purposes. By Lieut.-Commr. Wallace L. Lind, U.S.N. Pp. v+225. (Boston and London: Ginn and Co., 1920.) Price 10*s*. net.

COMMANDER LIND addresses his preface from the United States Naval Academy at Annapolis, and the book doubtless represents the instruction there given on the subject of the internal-combustion engine. For such a purpose the book is very well suited: the theoretical work is sufficiently elementary, and the sections describing practice, although apparently slight, are just such as young cadets can grasp and appreciate, whilst realising how much there is behind to be worked at if they should think of preparing themselves for specialist courses. Such books are *sui generis*—they make little appeal to trained engineers and are too vague for university courses, but for their own special purposes they are excellent. They enable an officer to have enough general knowledge to give adequate directions to the ratings under him.

The sections devoted to motor fuels and carburettors are much fuller than the rest of the book, and are evidently written by one who has given special attention to these topics. The point of view is American, and the illustrations mainly relate to trans-Atlantic models, though reference is made to some of the more important European types—quaintly mentioned in one place as those of the "belligerent nations of Europe."

A Monograph of the British Orthoptera. By W. J. Lucas. Pp. xii+264+xxv plates. (London: The Ray Society, 1920.) Price 25*s.* net.

WE heartily welcome the appearance of this useful work, for there is no doubt that a complete monograph, on any order of insects, is a great stimulus to its further study in the country concerned. Our British Orthoptera have been rather neglected in the past, but Mr. Lucas's papers, which have regularly appeared in the entomological magazines, have done good service in awakening an interest in our native species. No one, therefore, is better qualified than he is to write a Ray Society volume on the order. The book is strong on the biological side, habits, times of appearance, and distribution being adequately treated, and many interesting facts are thus collected together. We should have liked to see a fuller account of the structure of Orthoptera and some remarks on their internal organisation, but recognise that the author probably has had to limit his pages very considerably owing to the expense of publication. The earwigs are regarded as a suborder rather than as constituting a separate order: out of twelve families only one—the Ectobiidæ—contains indigenous species. The crickets are represented by four species, including the remarkable and seldom observed mole cricket (Gryllotalpa). Only nine species of long-horned grasshoppers are known with certainty to be natives, though possibly *Phaneroptera falcata* may eventually prove to be indigenous. There seems to be but a single record of a Locustid from Scotland and, in fact, our scanty British fauna compares very unfavourably with the 160 Western European representatives of the Locustodea. Of the short-horned grasshoppers, Mr. Lucas recognises eleven species, but none are migratory locusts. The twenty-five plates illustrating the work are on the whole adequate, though we fear Nos. 7, 14, and 19 have reproduced the objects concerned on too small a scale to be of very much service. These can scarcely fail to be a source of disappointment to the author, who is an expert in the art of delineation.

A. D. I.

Grain and Chaff from an English Manor. By A. H. Savory. Pp. viii+311. (Oxford: Basil Blackwell, 1920.) Price 21*s.* net.

THE village described is Aldington, in the Vale of Evesham, situated at the foot of the Cotswold Hills, and the author sets out his recollections of the people and the village life as he has known them during his residence. It is not a survey in the ordinary sense; it is rather a record of the trivial features of everyday life during the past thirty years in the village, which will no doubt prove of interest to readers who enjoy reading about country matters. The details of the farming are not described, and although figures are sometimes mentioned in connection with prices, there are no dates to give precision or to allow of any check. The book is concerned almost wholly with the village inhabitants, and its interest is literary rather than scientific.

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.*]

The British Association.

WE are hoping to reply in due course to the criticisms which have been made in the columns of NATURE on the present position of the British Association, but in order to do so with proper effect we are inviting from various presidents and secretaries of Sections an expression of their own views of the correspondence. We hope that it may be possible to summarise these views for the benefit of your readers without undue pressure of space. Meanwhile, it may be of interest to give at full length the following remarks from the president of Section A. It should be remembered that these were not written for publication, but, as above stated, for our consideration along with other similar documents, and publication *in extenso* has been permitted by Prof. Eddington only at our special request.

H. H. TURNER.
JOHN L. MYRES.

New College, Oxford, October 10.

IT is important not to confuse two distinct aims: (1) to make the proceedings less specialised, and (2) to make them more popular. I believe that in practice these two aims are often found even to be opposed. The committee of Section A has often arranged joint discussions with other Sections—a typical way of broadening our proceedings—but not in the least with the idea of attracting the public. I think the idea was that, by bringing together a number of experts with different points of view, a discussion would result which would advance science, but would necessarily be rather beyond the comprehension of most of us.

(1) I am all in favour of avoiding specialisation. The meeting of the British Association is a unique occasion in the year, and is wasted if the programme is on the same lines as those of the specialised societies which meet frequently. I would, however, deprecate the idea that the chief means of accomplishing this must necessarily be by joint meetings of Sections; this may be encouraged in moderation, especially between those Sections which (some of us think) might well never have separated. Where, as in Section A, we have a wide range of subjects the adherents of which do not usually meet together during the year, there is less need to join other Sections, and there would often be difficulty in finding a large enough room.

The drawback to a joint discussion is the multiplicity of speakers and the absence of a unifying purpose; that is how those to which I have listened strike me. If, for example, Section A should decide to give some time next year to aviation problems, I think it would be more profitable, not to arrange a joint meeting with the Engineering Section, but to invite an expert (an engineer, perhaps) to set the problems before Section A in a non-technical way. No doubt other engineers will come to hear him and make remarks on his paper; but he will have had a definite task before him to make the problems and results clear to astronomers, mathematicians, geophysicists, etc., not to argue with other experts about stalling angles and other mysterious technicalities. An illustration of this was provided this year when Prof.

Bragg addressed the Geology Section on X-rays and crystal structure; I think this was as useful as a joint meeting with Section A would have been.

(2) I very much doubt the assumption commonly made that the application of science to life and industry is what the public want to hear about. It may be good for them to hear about it, but we shall have to gild the pill with more attractive subjects, such as the age of the earth, the excavations at Cnossus, the properties of prime numbers, or Einstein. The public that we are trying to reach may be interested in the application of X-rays to atomic structure, but a paper on the latest X-ray apparatus in the hospitals would be hopelessly dull. May we not draw a moral from the fact that the best-attended Section at Cardiff seems to have been that which devoted its whole programme to pure science and scarcely touched on any industrial applications? To lay stress on the valuable material *results* of science may be the best way of touching the pockets of commercial magnates, but the British Association has also the missionary task of encouraging interest in the *methods* of science and of spreading the true scientific spirit.

The question remains: Can anything be done to set forth in a more popular way the methods of science in the towns we visit? I think anything that is done must be outside our Sectional proceedings. To popularise them would merely result in the majority of professional scientific workers staying away, leaving only those interested in scientific propaganda. Although some of our ablest men of science have the gift of being able to deliver attractive popular lectures, the majority have no special aptitude or inclination for this, and there is no reason whatever why they should. If they have trained themselves to be able to explain their work lucidly to those who have been educated to understand and criticise, they have done their part, and may leave to others the work of propaganda. We must avoid the painful spectacle of a brilliant investigator placed in an unfamiliar position before a popular audience and trying to talk down to them—a task performed much better by a man with a tenth of his knowledge, but who has practised the art of popular lecturing. Moreover, the public wants his very latest conclusions, stated without the conditions and reservations which they do not understand; and when next year he alters his opinion in the light of further advances, they will deride him and men of science generally for advertising sensationally themselves and their half-baked conclusions. It is right that we should try to make some more direct return to the public in the towns the hospitality of which we enjoy; but the difficulties and dangers are so obvious that it is desirable to proceed very cautiously.

References to the good old days of the Association, when Kelvin, Maxwell, and others would argue by the blackboard and the audience could watch new discoveries emerging, produce in my mind an effect opposite to that apparently intended. It makes me realise how greatly the Association has advanced since then. In these days, too, we have a big X, Y, Z whose views on any subject under discussion would have delighted the audience, and their presence and happy way of saying the right thing or putting an encouraging question when it was needed cannot be too highly valued. But more often X shook his head, and a whisper from the Recorder reminded me that X (a name scarcely known to the majority present) had made a life-study of the particular problem, and it was he who enlightened us. The great democracy of scientific workers is a product of the newer age, and nowhere does one feel that sense of equality and fraternity so convincingly as at the British Association. A. S. EDDINGTON.

WITH reference to the views expressed by correspondents in NATURE as to the future of the British Association, based, it would seem, in large measure on the rather disappointing attendance at the recent meeting at Cardiff, it appears to me there were reasons for this irrespective of any decadence of the Association. May not the date being so near the height of the holiday season—viz. the end of August rather than the beginning of September, as on so many previous occasions—be accountable for the absence of some members? In these times there are more counter-attractions than formerly for scientific workers and others interested in scientific or professional subjects in connection with their own special annual gatherings. Having yielded to the claims of these, they cannot afford the time or expense of attending the British Association meeting in addition. For example, a friend of mine residing in South Wales, whom I hoped to meet at Cardiff, expressed his regret at not being able to be present, as he had to expend all his spare time during the first two weeks in August at the national Eisteddfod of Wales at Barry and the annual meeting of the Welsh Bibliographical Society also held there, and at the Cambrian Archæological Association meeting in Gower. In some instances the increased railway fares (and no reduction as formerly) and hotel and other expenses acted as deterrents, and not any falling off of interest in the Association that kept many away. The bulk of the usual attenders at the British Association belong to the class who have been most severely hit by the present hard times.

WILSON L. FOX.

Carmino, Falmouth, October 5.

Recapitulation and Descent.

THE passage entitled "Recapitulation as Proof of Descent" in Dr. Bather's "Fossils and Life" (see NATURE for September 30, p. 162) calls for critical comment, inasmuch as it is representative of inconsequent reasoning current in several text-books commonly in use among students.

If experimental breeding justified the inference that a mutant form should recapitulate the characters of its ancestral stock, the observed fact that developmental stages in the life of an organism frequently resemble adult forms which are antecedent to it in the time process would constitute a cogent consideration for regarding these antecedent forms as ancestral to such an organism. But genetic investigation does not at present lead to such a prediction, and hence it is perfectly evident that recapitulatory phenomena do not provide direct evidence for evolution. Hitherto experiment has not thrown any light on the genetic significance of recapitulation, except so far as to suggest that factorial elimination rather than any "perennial desire of youth to attain a semblance of maturity" (whatever this may mean) is the key to "the omission of some steps in the orderly process."

As Sedgwick many years ago emphasised, for the purpose of the general theory of evolution recapitulatory phenomena are of interest only as extending the law of unity of type; while the value of embryological data for phylogenetic speculations resides logically in the fact that the embryologist studies the entire sequence of structural arrangements which characterise a living organism, whereas the comparative anatomist of adult life pays attention to only one of them.

It is easy to appreciate that in a generation which was obsessed with the "immutability of species" recapitulatory phenomena would greatly influence the minds of persons otherwise slow to recognise the varying degree of similarity and dissimilarity in the combination of genetic characters which living forms exhibit; the palæontologist shows that these varying degrees of similarity and dissimilarity have been brought about by progressive differentiation in both time and place; but, as Dr. Bather rightly insists, succession (progressive differentiation) does not of necessity imply descent. The final step in the argument for evolution (*i.e.* the theory that progressive differentiation has been effected through the agency of the process of reproduction) is that organisms are known to be derived only from pre-existing organisms, and that new genetic characters are from time to time differentiated in the actual course of normal generation; hence to interpret the diversity of genetic characters in living forms *in terms of experience* it can only be inferred that such diversity has been brought about in the course of descent.

It appears to me that the paramount necessity for clear statement on the logical position of the evolution theory is: (1) To recognise that much of the reasoning employed in the past originated in the emotional atmosphere created by popular prejudice and hostility; and (2) while appreciating the fact of specificity (genetic stability), to dispense entirely with the arbitrary notions connected with the term "species" as employed by systematists. It is interesting to note in conclusion that Darwin himself regarded the facts of ontogeny as an extension of the law of unity of type rather than a contention *sui generis* in favour of the theory of evolution.

LANCELOT T. HOGBEN.

Imperial College of Science,
South Kensington, S.W.7, October 2.

I AM much obliged to you for letting me see Mr. Hogben's most interesting letter, and I thank him for emphasising the fact that the mutants of the experimental breeder do not show such recapitulatory phenomena as do the mutations of the palæontologist. Since this point was dealt with, however imperfectly, in the address, I surmise that Mr. Hogben has considered only the extract published in NATURE. His statement of "the final step in the argument for evolution" appears to me consequent, but I am not yet prepared to admit that my statement was inconsequent. Neither, I fear, is absolutely conclusive. Consequent or inconsequent, I did my best to view the problem without prejudice or emotion, but I plead guilty to some attempt at humour.

F. A. BATHER.

A Fracture-surface in Igneous Rock.

THE accompanying photograph (Fig. 1) was taken by me some years ago during the construction of the Shirawta Dam, Bombay Hydro-Electric Works, India. It shows a curious fracture surface due to a heavy gelignite detonation in finely crystalline "trap" rock. So far as I can remember, I had seen other examples of this phenomenon, but photographed this as it was a particularly good one, and I thought it would be of special interest to "elasticians."

B shows the "splash effect," having its origin at the bottom of the $1\frac{1}{2}$-in. diameter vertical drill-hole A. C is a two-foot rule used to fix the scale. E is the vertical edge of a fault (or possibly a dyke) in the "trap" rock. D points to one of the faint radial "splash" lines that form a sort of aurora about the explosion centre A.

It will be noticed that the "splash" at B looks like the fluting of a large fossil. The Deccan "trap," however, is an igneous rock, and, of course, has no fossils in it. Tentative explanations that may be advanced are (*a*) that the pressure at A was so enormous at the moment of detonation that an actual flow of the rock took place; (*b*) that the fluted surface is the result of unequal stress distribution due to "interference" between waves reflected from the three reflecting surfaces. These surfaces are: (1) The rock surface some 10 ft. to 20 ft. above and parallel to the foot-rule C. (2) The face of the fault E. (3) The original face of the cutting lying in a plane parallel to the plane of the paper and, at the most, 2 ft. in a line normal to the paper from the points A and B.

The distance to the original face before the blast would not be more than 6 in. to 1 ft. from the top of the drill-hole shown. The hole was drilled in the side of the rock cutting having a "batter" of about one in five, at the stage when the photograph was taken. The drill-hole A would probably be about $3\frac{1}{2}$ ft. deep, and the point A about 5 ft. above the floor of the cutting.

It should also be mentioned that the site of this explosion was the side of a rock cutting about half a mile long, with level bottom leading to the Shirawta-Walwhan tunnel. The rock cut at the shallow end would be about 3 ft. deep, and at the tunnel end about 40 ft.; its top width was 20 ft.,

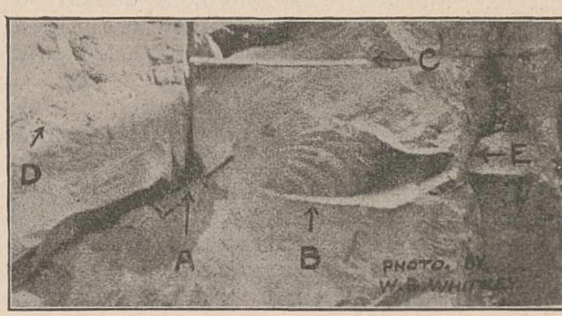

FIG. 1.—Splash-like fracture-surface due to gelignite explosion in rock A, base of $1\frac{1}{2}''$ diameter drill-hole and origin of explosion; B, fluted "splash effect"; C, 2-ft. rule, to fix scale; D, one of a number of radial "splash" lines.

and its width at the bottom was, at that date, from 5 ft. to 10 ft.

Samples of rock similar to that blown away from A were weighed, and their specific gravity worked out at between 2·720 and 2·752 (taking the weight of a cubic foot of water as 62·5 lb.).

(Prof. B. Hopkinson calculated that the maximum pressure at the face of an explosion of 1 oz. of gun-cotton is of the order 100 tons per sq. in., and that this maximum is attained in 1/400,000th of a second.)

Since writing the above, it has been suggested that the phenomenon is a large example of conchoidal fracture. In any case, I think the photograph will be of interest to readers of NATURE.

W. BEVAN WHITNEY.

Meadow House, Layters Way,
Gerrards Cross, Bucks, September 19.

A Visual Illusion.

THE visual illusion described by Mr. Turner in NATURE of October 7, p. 180, may be seen very well by looking steadfastly at a long luggage train as in, for example, counting the trucks at about 100 yards distance. Immediately after the train has passed, the embankment appears to slide along in the opposite direction.

A. E. BOYCOTT.

17 Loom Lane, Radlett, October 10.

The Behaviour of Time Fuzes.

By PROF. A. V. HILL, F.R.S.

THE time fuze is a device for exploding a shell at any desired interval after it is fired. Before the late war the time fuze was used mainly with shrapnel shell, to burst the shell in the air and so propel the bullets down on to the objective. For this purpose the ordinary "powder-train" fuze gave—considering its simplicity—remarkably good and consistent results; at any rate so good that no serious impetus had been given to a proper scientific study of its properties under a variety of conditions. The development of anti-aircraft gunnery, however, in which the employment of a percussion fuze was useless, and in which the target moved so fast that no preliminary "ranging" on it was possible, not only required a much greater reliance to be placed on the accuracy of the time fuze, but also subjected it to much more severe conditions than had ever occurred before. The conditions referred to were those set up by variations of velocity, air pressure, spin, and temperature. Moreover, the enormous quantity of powder suddenly required for military use made it difficult for the manufacturers to produce it with the same quality and consistency as of old. All these factors led to a series of extraordinary difficulties in connection with time fuzes, such as irregular burning and a wholesale failure to burn at all; these difficulties were never completely overcome in practice, but they stimulated a much fuller investigation of the factors governing them, and have resulted in a far greater understanding of the physical behaviour of fuzes. As so often happens in the history of knowledge, urgent practical need led to scientific discovery.

The powder train fuze consists of one or more rings of highly compressed gunpowder forced into a metal groove. The ring is fired by a detonator at the moment the shell is accelerated in the barrel, and after a certain amount of it, adjustable beforehand, has been burnt it ignites a pellet which fires a second detonator which explodes the charge. The "fuze-setting," determining the length of powder to be burnt, and therefore the time of burning, is adjusted by turning the ring round an axis parallel to that of the shell. The gases produced by the combustion escape from a hole in the fuze, usually at the side, but sometimes in the nose. The position of this hole is of great importance, as will be shown below.

In a fuze at rest the time of burning is proportional to the length of powder burnt, and it has long been known that the rate of burning is a function of the atmospheric pressure. Very exact relations have been established between the pressure and the rate of burning under a variety of conditions, though their explanation is by no means clear, and some very interesting problems in the physical chemistry of combustion are provided by them. The gunpowder, of course, burns inside a closed ring, supplying its own oxygen, so that the effect of pressure is simply one of pressure as such. In the fuze fired in a shell from a gun the time of burning is by no means proportional to the length of powder burnt; usually the rate of burning is greatest at first (*i.e.* when the velocity of the shell is highest), decreasing gradually as the shell slows up until a more or less constant value is attained. In some fuzes, however, the rate of burning is least at first, increasing later on. Indeed, in some cases the same fuze may show one phenomenon when fired in one shell, and the opposite when fired in another. This complex relation between length of powder burnt and time of burning has received a complete explanation in the theory of the "dynamic pressure" at the escape holes. When a body moves rapidly through the air the pressure at any given point varies with the speed, and at any given speed varies from point to point of the shell. So completely does this theory explain the phenomena that an observed relation between "fuze-setting" and time of burning has been used even in the converse way to determine the pressure at a variety of points on the head of a shell moving at various speeds up to 1600 ft. per second. It is possible, of course, for the "dynamic pressure" to be a negative one—*i.e.* to be a "suction"—in which case, if it be sufficiently large, the powder may refuse to burn at all, and the shell will be "blind." This will be the case if the escape hole be too far back from the nose of the shell, or be under the lee of a projection on the fuze. It is necessary to take particular account of these factors in the design of the fuze body.

The scientific development of the theory of fuze burning dates largely from a trial carried out in the winter of 1916–17 at Portsmouth, in which a large number of fuzes of the same type and "lot" was fired to various heights up to 20,000 ft. in exactly similar shells, from five different 3-in. guns differing only in respect of their muzzle velocities. The results were very peculiar, and at first almost incredible; it was found that the effect of a given fall of atmospheric pressure in the upper air, whether in lengthening the time of burning or in producing a liability to irregularity and "blinds," was far greater in the case of a shell fired from a high-velocity gun than it was in the case of one fired from a low-velocity gun—quite independently of what its actual velocity might be at the moment considered. A given fuze in a given shell, moving at a given velocity, at a given reduced atmospheric pressure in the upper air, might be expected to burn at a definite fixed rate. It did not! The rate of burning depended on the previous history of the shell—viz. on the velocity with which it had left the muzzle of the gun. What effect could this previous velocity have left upon it? The mystery was so complete that one was clearly on the eve of a discovery. Various theories were put forward to account for it, such, for example, as that the shell "yawed" from its path to a degree varying from gun to gun, the "yaw" being supposed to affect the pressure at the escape holes, and therewith the time of burning. The true explanation, however, proved to be the hitherto unsuspected effect of "spin"—*i.e.* the angular velocity of the shell about its axis, and this factor has since proved practically the most important one in the behaviour of a powder train fuze. The shell, in order to secure stability in its flight, is given a high angular velocity by the rifling of the gun working on the copper driving-band. In all the guns employed (varying in velocity from 900 f.s. to 2500 f.s.) the twist of the rifling was 1 turn in 30 calibres—*i.e.* in 30 times 3 in. or $7\frac{1}{2}$ ft. This gave angular velocities varying from 7200 to 20,000 revolutions per minute in the five guns. The angular velocity of a shell falls off comparatively slowly in flight, so that it could be regarded as approximately constant along the trajectory of each gun. The peculiar differences observed in the gun trials could be explained only as an effect of spin, and it was clearly necessary to carry out spinning trials on fuzes "at rest"—*i.e.* without forward velocity—to see if the effect of spin could be isolated. Such trials were carried out at speeds up to 30,000 r.p.m., and an enormous effect of spin was established. It was possible to double the time of burning of a fuze, or even to make it cease burning altogether, merely by spinning it. The effects of a fall of pressure also were exaggerated by spin, as was shown in the laboratory at University College, by spinning a fuze under reduced pressure.

The explanation of this effect of spin is interesting. It could not be due to any "dynamic pressure" effect at the escape holes, or to a centrifugal effect on the gases in the groove; these were investigated and found to be far too small. The real explanation is the centrifugal effect on the slag produced by the gunpowder in its combustion. When the spin is high the gunpowder, warmed, softened, and just ignited by the combustion of the previous layer, is "spun" outwards to the outer edge of the groove before it has had time properly to burn and to ignite the next layer; consequently, combustion is slower, and may fail altogether. The absence of any effect of spin in the case of a special powder giving no slag, as well as the fact that "blind" fuzes are found to have failed first on the *inside* edge of the ring, make it clear that the centrifugal effect on the slag is the prime cause of the trouble. At 30,000 r.p.m., a spin reached in fuzes fired from small guns, it is almost impossible to attain any accuracy at all. The rapid increase of fuze-trouble with spin is due to the fact that the centrifugal effect varies as the *square* of the spin.

One obvious means of avoiding the excessive effect of spin was to reduce the rifling of the gun and therewith the rotation of the shell. The possibility of doing this is strictly limited, as with too low a spin the shell becomes unstable. Two similar guns were rifled respectively 1 turn in 30 and 1 turn in 40 calibres, and in all respects the fuzes fired from the latter were found to behave more satisfactorily, thus confirming the results and predictions of laboratory trials. All similar guns were provided thereafter with the smaller rifling, with good effects.

Another factor affecting the behaviour of fuzes is their temperature. This effect, also previously unknown, is a smaller one, but by no means negligible. A fuze burns more quickly at a higher temperature, and allowance must be made for this in accurate firing. A curious phenomenon arises in connection with this. It was usual to test a fuze at rest as well as in the gun, and in the case of some long-burning fuzes at rest the fuze heats itself by its own combustion to such an extent that its time of burning is seriously decreased. This "self-heating" effect does not occur in a fuze fired from a gun, which is cooled by its passage through the air. Consequently, for accurate comparison with gun trials the fuze fired at rest must be cooled while it burns—*e.g.* by subjecting it to a rapid spray of water. This was actually done in later trials, the fuze being rotated in a closed box at any required spin and pressure, and subjected the while to a rapid jet of water to ensure the constancy of its temperature.

We may summarise as follows: The rate of burning of a fuze is a function of the total pressure at its escape holes, which is made up of the atmospheric pressure A and some function $f(v/V)$ of v its velocity and V the velocity of sound. It is a function also of the spin S and of the temperature T. Expressed mathematically, the rate of burning is equal to $F[\{A+\rho f(v/V)\}, S, T]$, where F is some complicated function of the three variables. It is easy to see that fuzes are likely to cause trouble when subjected to conditions, as they were in the late war, far exceeding in severity any under which they had previously been used; and to foretell that in the next war—if there be one—reliance will be placed mainly on clockwork fuzes unaffected by these various factors.

The Iridescent Colours of Insects.[1]

By H. Onslow.

III.—Selective Metallic Reflection.

In the two preceding articles various insects have been described and illustrated, which owe their principal iridescent effects to the colours of "thin plates" and to the diffraction of ribbed structures or "gratings." However, more than one physicist of repute has stated that most insect colours are due to selective metallic reflection. The arguments against this theory, as applied to scales, were considered in the first article; briefly, they are due to the facts that both reflected

[1] Continued from p. 183.

and transmitted colours disappear when scales are immersed in fluids of a highly refractive index, and that all colours vanish when scales are subjected to pressure, as could scarcely be the case if the colours were due to some molecular structure, such as a film of aniline dye.

Now in the case of scaleless beetles and in many other iridescent structures, including bees and dragon-flies with bright, metallic wings, (1) the colour does not disappear on exerting pressure; (2) the reflected colour does not disappear on immersion in fluids of high refractive index, even when penetration is facilitated by a vacuum; and (3) the transmitted colour, so far as this can be seen, also persists. It is worth noting that the data which Michelson relies on to show the similarity in the behaviour of polarised light, when reflected from iridescent insect structures and films of aniline dye, fit the wing-cases of beetles much more closely than they do the wings of butterflies or the feathers of birds.

Sections *1* and 2 of Fig. 1 show typical iridescent wing-cases. Section *1* is that of the common green Rose Beetle (*Cetonia aurata*) and section 2 that of a beetle with a peculiar sheen (*Anomala dussumieri*), due to the numerous dome-shaped protuberances, *b*, seen in section. The surface of the chitin is protected by a thin cuticle, *c*, $0{\cdot}5\mu$ thick, but there appears to be no structure likely to produce colour. It is clear that this film cannot cause the colour, because the wing must have a protective sheath of some sort, otherwise the colour would disappear as soon as the surface came into optical contact with a refractive fluid. Consequently it is very important to determine exactly at what depth the colour-producing layer is situated, in order to decide whether there is room for an adequate structure to exist above it.

For this purpose a wing-case was carefully polished under the microscope with a paste of the finest carborundum and cedar-wood oil. On removing the surface-layer, a very remarkable change of colour was observed to have taken place. Sections were cut from suitable portions of the polished area, the exact colour and position of which could be determined. A composite picture of three different sections is shown in *3* (Fig. 1). To the extreme right of section *o* the cuticle, *c*, is untouched, but further on it is partly removed, and the lowest point seems to have been reached near *b*, in section *n*. Somewhere here the colour changes to magenta, but as soon as the irregular dark line dividing the cuticle from the lower layers is passed all colour vanishes, and the black chitin is exposed, as at *a*, in section *m*. Thus it appears that this line running underneath the cuticle is the seat of the colour-producing layer, and its extreme depth is about $0{\cdot}5\mu$ below the surface. This figure, which was obtained with the microscope, was checked by an indirect method of measurement, and the two results were found to agree with sufficient accuracy.

There appears to be a choice between two alternatives: (1) the colour may be due to a single thin film, which must lie under a protective sheath of some description, or (2) it may be produced by a layer having properties similar to an aniline dye. Although it is possible to show that under suitable conditions single films could, by interference, produce colours as bright as those shown by beetles, the second alternative appears the more probable. This is principally because of the exceedingly small distance between the surface of the wing-case and the lowest limit of the colour-producing layer. Within the space of $0{\cdot}5\mu$, room must be made both for the protective cuticle and for the thin film itself. This might, indeed, be just possible, but is unlikely, because of the peculiar sequence of the colours caused by reducing the thickness of the iridescent film in polishing.

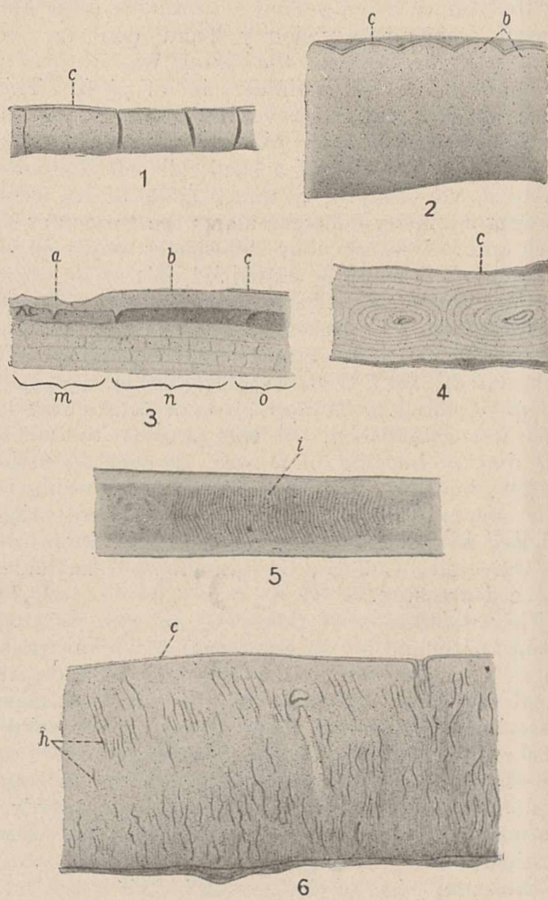

FIG. 1.

1, Surface layer, or "*Emailschicht*," of *Cetonia aurata*. *c*, surface cuticle.

2, Wing-case of *Anomala dussumieri*. *c*, cuticle; *b*, knobs or bosses.

3, Composite section of *Plusiotis resplendens* after polishing. *m*, underlying chitin; *n*, magenta portion: *o*, unpolished portion; *a*, black chitin; *b*, magenta film; *c*, surface cuticle.

4, Wing-case of *Thlaspidomorpha balyii*. *c*, surface cuticle.

5, Hair of *Chrysochloris aurea*. *i*, imbricated scales.

6, Scutum of tick *Amblyomma hebraeum*. *c*, surface cuticle; *h*, black hair-like canals filled with air.

These sections were all drawn to the scale μ=1 mm. with Zeiss 2 mm. apochromat, N.A. 1·4, and Comp. Oc.

This appearance is difficult to describe, and must be seen to be appreciated fully. On polishing the brilliant gold beetle *Plusiotis resplendens,* no effect is at first seen, except perhaps a slight dulling of the lustre. The golden surface, scarred and scratched by the polishing crystals, remains unaltered for a period, which appears to depend on the thickness of the cuticle. Then, at a certain depth, the gold is suddenly replaced by a metallic magenta, and where this is seen to shine through a very thin film of gold, a silvery-blue effect is produced. On continuing to polish, the magenta rapidly disappears, revealing the black underlying chitin. These changes may be closely imitated by gently polishing a thin film of gold deposited electrolytically on copper. Similar effects are also seen when a copper sheet is gently heated in the steam-oven until films of oxide are formed. It is worth mentioning that Mallock has shown, by means of polishing experiments, that the coloured films of steel oxide are not due to interference in the manner usually supposed.

In the case of these beetles it may be objected that the colour of a thin film *would* change if its thickness were reduced by polishing in the above way. The change of colour, however, would be gradual, and not abrupt as is the case. Moreover, the sequence of colours would be different from that which actually occurs, as, for instance, when bluish-green and green wing-cases change to crimson or scarlet.

Some Iridescent Colours which Depend on Moisture.

The small beetles, forming the group known as Tortoise Beetles, throw considerable light on the question of surface colours by their behaviour in various fluids. Many of these beetles are golden when alive, or when preserved in spirit, but brown when dry. The colour, however, returns on soaking them in alcohol, but not in all other organic fluids. Section 4 (Fig. 1) is cut from a wing-case which has a thin cuticle, *c*, and is in other respects almost exactly like that of an ordinary scaleless beetle that retains its colour after drying. Moreover, the colour does not disappear under pressure, but here the resemblance ceases, for, curiously enough, the golden glitter remains, even after the cuticle has been polished away, so long as the surface is kept moist. In fact, almost the whole wing-case may be ground away before the metallic lustre disappears. It is obvious, from this curious behaviour, that the whole thickness of the surface layer of chitin is concerned, when in a moist condition, in reflecting a lustre, somewhat in the same way as pebbles on a beach glitter in the sunshine when washed by an advancing wave. Even vertical cracks in the chitin are seen to have golden sides. The reason for this behaviour is clear. When dry, aqueous alcohol and certain fluids can penetrate the cuticle, but other organic fluids cannot. The colour does not return immediately after immersing the beetle, but it must soak, because the protecting cuticle is pervious only with some difficulty. For the same reason, once it is wet, the colour takes some time to disappear, because the cuticle prevents the moisture from evaporating, as it must no doubt do when the beetle is alive. The fact that the whole thickness of the chitin layer reflects metallic colour suggests that, in scaleless beetles, colour may be due to a skin of chitin having the same properties as that of the Tortoise Beetles, but with the surface so polished that moisture is not necessary for the development of the colour.

Some of the most interesting beetles of this group are those which, though colourless when dry, develop a brilliant iridescence on being moistened with a wet brush. There is a remarkable bug with these properties, named *Pycanum rubens,* which is a bright apple-green when alive or in spirit, but a dull purple-brown when dry. Experiments were made in various fluids, and it was found that in alcohol, which was completely dehydrated by metallic calcium, immersion produced no colour. But the slightest trace of water caused the colour to return, and dilute acid had the effect of making it more or less permanent. Pressure experiments showed that there was no surface colour due to a molecular structure, because the colour completely disappeared, to return again as soon as the pressure was removed, just as the colours of thin films should do. These and other observations made it probable that the colour arose in a thin membrane with, like gelatin, a specific power of absorbing water, but not other organic solvents. When dry, the membrane must be too uneven to cause regular reflection, but as soon as it is swollen with water it can give the colours of thin films.

The third example of this type of iridescence was found in certain metallic ticks first described by Prof. Nuttall. When dry, they are a dull ochre, and in most anhydrous fluids a matt silver, like freshly cut aluminium, but in aqueous fluids they show bright metallic colours, both green and red. Reference to a section of the scutum, 6 (Fig. 1), shows that a protective cuticle, *c*, covers a thick layer of chitin interpenetrated by innumerable tiny air-canals, *h*. It is probable that, when dry, the white light reflected from this air renders all structural colours invisible; but when an aqueous fluid, which can penetrate the cuticle, fills these canals, the dark background produced clearly shows up the colours which may, or may not, be due to an absorbent membrane, as in the case of *P. rubens.*

In the course of these investigations many other very interesting iridescent structures were examined, for a description of which there is here no space. Many of these revealed no adequate colour-producing structure, and they present a most interesting field for further research. Among the most striking objects are the green metallic wings of certain bees and dragon-flies, such as some of the Carpenter bees, and *Neurobasis chinensis.* These very brilliant and thin structures behaved in many ways like the wing-cases of scaleless beetles. There are also the iridescent eyes of many Diptera, and the amazing iridescent hairs of a mammal, the Cape Golden Mole, *Chrysochloris aurea*, 5 (Fig. 1), showing the fine imbricated scales, *i*. In addition there are the brilliant *setae* of the "sea-mouse," a marine worm (*Aphrodite aculeata*). In plants not many iridescent structures are found, with the exception of the beautiful Pteridophyte, *Selaginella Wildenovii*, which glistens with a very strong blue and purple metallic sheen.

Obituary.

ARTHUR SIDGWICK AS NATURALIST.

THE admirable notice of the late Arthur Sidgwick in the *Times* of September 28 describes him as "naturalist," as well as "scholar" and "politician." It is a true and just description. The love of natural history developed early, and was always one of the strong and essential elements in his intellectual life.

Sidgwick was twenty-seven, and had been a master at his old school—Rugby—for three years, when Wallace's article "On Mimicry and other Protective Resemblances among Animals" appeared in the *Westminster Review* for July, 1867, and it had the same effect upon him as, in its later form, reprinted in the "Essays on Natural Selection," it had on the present writer. A few months after reading it, Sidgwick, on November 9, read his paper "On Protective Resemblances among Insects" before the Rugby School Natural History Society (pp. 23–26 of the report for 1867), in which he not only gave an admirable review of the article, but was also able to draw on his own past experience as a naturalist for illustrations. There is one slip in his reference to Wallace's account of Bates's epoch-making paper, for he spoke of the Heliconidæ and their Leptalis mimics as "white," whereas they are brightly coloured, while the Leptalis, abandoning an ancestral white, have become brightly coloured also.

Among Sidgwick's original observations in the paper, the following are quoted by Wallace in his revised essay (p. 45 of the 1875 edition):—

> I myself have more than once mistaken *Cilix compressa*, a little white and grey moth, for a piece of bird's dung dropped upon a leaf, and *vice versa* the dung for the moth. *Bryophila glandifera* and *perla* are the very image of the mortar walls on which they rest; and only this summer, in Switzerland, I amused myself for some time in watching a moth, probably *Larentia tripunctaria*, fluttering about quite close to me, and then alighting on a wall of the stone of the district, which it so exactly matched as to be quite invisible a couple of yards off.

Observations of this kind were far from well known in those days, only a few years after the appearance of the "Origin of Species."

Sidgwick was a man of strong opinions; what he believed he believed intensely. Yet, with all this, he was exceptionally modest. I recall a later paper of his on the same subject as the earlier, read before the recently established Oxfordshire Natural History Society. In the discussion some criticisms were passed upon the relative value of the destructive agencies of which he had spoken. He accepted the remarks of much younger members with perfect kindliness, and ended by saying that he hoped "to do better next time."

These memories lead naturally to thoughts of his simplicity, and with it his delightful and infectious boyishness. One came in to ask for his ever-ready help in coining some scientific term, and found him testing his latest toy, a little typewriter, and then everything must give way to a race between the player and the writer—the latter much handicapped by the banging of the machine; or a simple form of billiard table had displaced the heaps of books, and a game must be played; or a chunk of marzipan emerged and must be shared.

Sidgwick's sympathy with the aims of science in university life was not bounded by his love of natural history. In the conflicts which often arose, and were bound to arise, between the old, which is really modern, and the new, which is a return to the ancient ways, Sidgwick always supported science. I never knew an exception in the years when we were closely associated.

Among the notices and memories of Arthur Sidgwick I have seen, there has been no reference to the two volumes of "School Homilies," addressed, from 1870 onwards, to the boys in Canon J. M. Wilson's House at Rugby. The addresses deal, as Canon Wilson says in his introduction, "with apparently commonplace subjects, but they lifted every subject out of the commonplace." They should be read by everyone who wishes to know the man and all that he stood for.

E. B. P.

BY the death of M. LOUIS DUCOS DU HAURON we lose one of the foremost pioneers in the photography of colour. M. du Hauron was born on December 8, 1837, and died on August 31 last. *La Nature* of September 25 publishes a portrait taken in 1877, and the *British Journal of Photography*, Colour Supplement, of October 1 gives the portrait by which he is generally known, taken evidently some years after the other, and a useful chronology of his work. It seems that he began the study of luminous sensations in 1859, and that by 1862 he had worked out a method of colour photography by means of three colour filters and complementary printing; but his chief contributions to the subject are contained in two small volumes, which, unfortunately, are now very rare—"Les Couleurs en Photographie: Solution du Problème," published in 1869, and "Les Couleurs en Photographie et en particulier l'Héliochromie au Charbon," published in the following year. In these publications he enunciated the principles of three-colour photography, including even the present "screen-plate" processes, such as the autochrome, Paget, and others. It was impossible then to carry out these processes satisfactorily, because it was not until 1873 that Vogel discovered the possibility of sensitising plates for colour, and it was still later that gelatine plates were commercially manufactured. M. du Hauron was a pioneer also in motion photography, stereoscopic work, and other matters.

THE death occurred on September 27 of DR. D. LLOYD ROBERTS at the age of eighty-four years. Dr. Lloyd Roberts was born in 1835 at Stockport, and received his medical education at the old Manchester Royal School of Medicine, and afterwards in the hospitals of London and Paris. In 1857 he obtained the diplomas of M.R.C.S. (Eng.) and L.S.A.; two years later he received the degree of M.D. from the University of St. Andrews, and became F.R.C.P. (Lond.) in 1878. During this period he was appointed honorary physician to St. Mary's Hospital for Women and Children, a post which he retained until his death. In 1902 Dr. Lloyd Roberts was president of the section of obstetrics of the British Medical Association, and he was also a member of numerous other medical societies. He contributed many papers to medical journals, and as early as 1876 published "The Practice of Midwifery," the fourth edition of which was issued in 1896. In other spheres he will be remembered as the editor of Sir Thomas Browne's "Religio Medici," first published in 1892, and for a short pamphlet read in 1914 before the Dante Society of Manchester on "The Scientific Knowledge of Dante."

MANY geologists in this country will regret to learn that their old friend, SVEN LEONHARD TÖRNQUIST, the doyen of Swedish geologists, died at Lund on September 6 from hæmorrhage of the brain. Törnquist's work on graptolites is familiar to all who deal with Lower Palæozoic palæontology and stratigraphy, and his writings on the geology of the beautiful Siljan district in Dalecarlia and on the relations of the Leptæna limestone have been a guide to many visitors for more than half a century. Papers were received from him up to the present year, for he still retained vigour of mind and body.

WE much regret to announce the death on October 1, at sixty-eight years of age, of PROF. ITALO GIGLIOLI, professor of agricultural chemistry in the Royal University of Pisa, Italy. Also of PROF. YVES DELAGE, professor of zoology at the Sorbonne, Paris, and member of the Academies of Science and Medicine, on October 8, at sixty-six years of age.

THE death is announced, on October 4, at sixty-five years of age, of DR. MAX MARGULES, secretary of the Zentralanstalt für Meteorologie und Geodynamik at Vienna.

Notes.

ON Monday, October 11, H.R.H. the Prince of Wales returned from his seven months' tour of the West Indies and our Colonies in the Pacific Ocean. When the Prince set out on March 17 it was intended that he should pay a visit to the Indian Empire, but this has been deferred until next year out of consideration for his health. However, during his long journey he has had an opportunity of seeing some of the diverse lands and peoples which go to make up the British Empire. To the credit of science, it can be put on record that during the whole course of the tour the Prince was never for a day out of touch with London. Telegraphy and "wireless" have made continual communication possible. It is also noteworthy that, in spite of encountering bad weather, the *Renown* kept to her time-table with great accuracy; marine engineers are to be congratulated on this remarkable achievement. The experience which the Prince has gained is invaluable to one who will some day have the task of ruling the Empire. His Majesty the King has voiced this sentiment in a letter which was addressed to the Secretary of State for the Colonies for transmission to the Governors-General and Governors of the Colonies which have been visited. He says: "May such mutual intercourse create fresh ties of confidence and devotion between the Throne and the generations, present and future, of these great lands, and thus promote the unity, strength, and prosperity of the Empire." The experience is also of importance in the study of problems of the moment, of reconstruction and all that it entails. That the Prince himself appreciates this is apparent from the following words from his reply to the address of welcome made by the Mayor of Portsmouth: "We are still, I fear, only at the beginning of the labours which are necessary to restore our credit and prosperity after the prolonged strain of the war, and I am deeply interested in our problems of reconstruction, which all parts of the nation must pull together to solve."

IN 1901 the German troops in Peking removed a number of old astronomical instruments from the city wall, and they were sent to Germany and erected at Potsdam. By the Treaty of Peace it was stipulated that they were to be restored. Col. Yate, hon. secretary of the Central Asian Society, announces in the *Times* of October 8 that twenty huge cases containing these instruments have arrived in China. Six of the instruments were constructed in 1673 by Father Verbiest, S.J., and one in 1715 by Father Kegler, S.J., and these are all copies of Tycho Brahe's instruments. To make room for them on top of the wall Verbiest removed thence two old instruments, which afterwards were put up in a court at the foot of the wall, where they stood until 1901. These two instruments had been erected in 1279 by the astronomer Ko-Show-

King from designs by the Persian astronomer Gemal-ed-din, and they are of considerable interest, being the earliest known equatorials. It is curious that Marco Polo never mentioned them, though he was at Peking when they were erected; but excellent pictures of them are given in Yule's "Book of Ser Marco Polo," third edition, vol. i., pp. 448 *sqq*.

THE *Morning Post* of October 7 contains the interesting announcement that next Saturday, October 16, a memorial tablet to Descartes is to be unveiled at Amsterdam. The tablet has been placed on No. 6 Westermarkt, the house where Descartes resided during the summer of 1634. Prior to the unveiling there will be a gathering at the University, at which M. René Doumie, director of the *Revue des Deux Mondes,* and Prof. Cohen, formerly of Amsterdam University, will speak. Descartes, who was born in 1596, came of a well-to-do family of Touraine, and was always in easy circumstances. Educated by the Jesuits, then the rising schoolmasters of Europe, he afterwards continued his mathematical studies with Mersenne and Mydorge. At the age of twenty he adopted the military profession, and saw active service with the Bavarian Army during the early part of the Thirty Years' War. The first ideas of his philosophy and of his analytical geometry are said to have come to him in three dreams on the night of November 10, 1619, when bivouacked at Neuberg, on the Danube. Descartes resigned his commission in the spring of 1621, spent the next few years in study and travel, and in 1629 settled in Holland, where he found the freedom from distraction necessary to the production of his great works. Twenty years later he accepted the invitation of Queen Christina to take up his residence in Sweden. The Queen wished to found an academy with Descartes at its head, but all her designs were frustrated by his death at Stockholm on February 11, 1650. Buried first in Sweden, his remains were afterwards taken to Paris, where after several removals they now rest in the church of St. Germain-des-Prés.

REPRESENTATIONS have on several occasions been made to the Government of the Union of South Africa, in particular by the council of the Royal Anthropological Institute, that it was urgently necessary that the study of the native population should be officially recognised and placed upon a properly constituted basis. The Government has, consequently, been much impressed by the great and urgent need for the scientific investigation of the ethnology, history and languages, customs, and religious beliefs of the Bantu race, and has now agreed to render substantial aid in the establishment of a school of Bantu life and language. Several university centres in the Union have from time to time asked for assistance to establish chairs in these subjects, but, acting on the recommendation of a Departmental Committee, the Government has decided that, for the present at any rate, it is desirable to concentrate such work. A school will, therefore, be established in connection with the University of Cape Town. A representative Committee, which includes the Secretary for Native Affairs, is now sitting to discuss the general scheme. It is anticipated that professors of Bantu ethnology and Bantu language will be appointed as a nucleus of the school at an early date.

SIR FRANK W. DYSON, Astronomer Royal, has been elected an honorary member of the American Astronomical Society. Prof. Kapteyn, of Groningen, is the only other living honorary member of this society.

UNUSUALLY warm and fine weather prevailed over England during the five days from October 5 to 9. On each day the sheltered thermometer at Greenwich was 70° or above, and the highest reading was 73° on October 5. On two of the nights the minimum temperature was 57°, and on two other nights 56°. The mean maximum temperature for the five days was 71° and the mean minimum 55°, both of which were 10° above the normal. There have been slightly warmer days at Greenwich very occasionally in the early part of October, the highest temperatures recorded since 1841 being 81° on October 4, 1859, and 79° on October 4, 1886. During the last eighty years there have been only twenty-two Octobers with a temperature so high as 70°, and only two previous Octobers, 1859 and 1869, with five consecutive days of 70° or above. In recent years the warmest weather in October occurred in 1908, when the thermometer exceeded 75° on each of the first four days, but the nights were much cooler than this year. Prior to the present year the thermometer at Greenwich has only once touched 70° in October during the previous nine years.

ON Thursday, October 7, at University College, London, Sir W. H. Bragg delivered a public introductory lecture on the history of science. A course of lectures on the general history and development of science was first introduced into the college curriculum last session. The course was specially required for students training for the new diploma in journalism instituted by the University of London. It was felt, however, that facilities for the study of the subject might be welcomed by a much wider circle, considering the important part played by scientific ideas and methods in the advancement of civilisation. Moreover, since the subject is obviously vast, it was deemed desirable to provide, so far as possible, courses on the history of special sciences in addition to the course on the general history of science. Accordingly, the number of lectures and lecturers for the new session has been increased considerably. A general introductory course will be given by Dr. A. Wolf; a course on the biological and medical sciences by Dr. C. Singer (first and second terms), and by Prof. W. M. Bayliss and Prof. J. P. Hill (third term); a course on Egyptian science by Prof. Flinders Petrie; a course on the history of astronomy by Prof. L. N. G. Filon; Mr. L. T. Wren will lecture on the history of mathematics (second term); and during the third term Sir W. H. Bragg, Prof. Garwood, Mr. Orson Wood, and others will deal with the more important developments of physical science during the nineteenth century. It is hoped that in due course there will be established at the college a flourishing school in the history of science in which teaching and research will both receive due attention.

Prof. F. Francis, professor of chemistry in the University of Bristol, has been elected a corresponding member of the Belgian Royal Academy of Medicine.

A Ramsay memorial fellowship of the value of 300*l.* a year for three years has been founded by subscriptions received from the Swiss Government and from Swiss donors through the good offices of Prof. Ph. A. Guye, of Geneva. The first fellow to be elected is M. Etienne Roux, of Vich (Vaud), Switzerland, who has decided to work in the laboratories of Prof. W. H. Perkin at Oxford.

Viscount Haldane, O.M., will give an address on "The Industrial Question" to members of the Institute of Industrial Administration at the Central Hall, Westminster, on Saturday, October 23, at 8 p.m. Sir Lynden Macassey will take the chair. Invitation tickets may be obtained from the hon. secretary, Mr. E. T. Elbourne, 110 Victoria Street, S.W.1.

The Thomas Vicary lecture of the Royal College of Surgeons of England will be delivered on Thursday, November 11, at 5 o'clock, by Sir D'Arcy Power, who will take as his subject "The Education of a Surgeon under Thomas Vicary." The Bradshaw lecture of the same institution will be delivered at 5 o'clock on Monday, December 6, by Sir Berkeley Moynihan. The subject will be "The Surgery of the Diseases of the Spleen."

The annual May lecture of the Institute of Metals for 1921 is to be delivered on May 4 next by Prof. T. Turner. The annual general meeting of the institute is to take place on March 9 and 10, 1921, at the Institution of Mechanical Engineers. The May lecture will be given in the same hall. An interesting programme of lectures in connection with the local sections of the institute at Birmingham, Glasgow, and Sheffield has been prepared. Among the lecturers are Lord Weir of Eastwood, Dr. W. Rosenhain, and Prof. C. H. Desch.

With reference to the letter which appeared in Nature for August 5 last, p. 709, on the loss of fragrance in musk plants, it is interesting to note that Mrs. W. H. Cope, joint secretary of the Birmingham Field Naturalists' Club, has observed a similar absence of perfume from all the musk plants which she purchased in the open flower market this year. The observation was corroborated by other members of the club, and a suggestion was made that the loss of odour was due to the atrophy of scent-producing cells consequent on a change in the type of insects by which fertilisation was effected.

The Rev. S. Claude Tickell informs us that a movement is being promoted at Santa Barbara, California, whereby all egg-collectors are invited to accumulate local eggs, with a view to world-wide exchange with other collectors. We agree with Mr. Tickell that the movement is crude and cruel, and that "recollection" by drawing should be substituted for "collection" and the consequent molestation of wild birds. For this purpose Mr. Tickell advocates the establishment of complete, permanent collections of birds' eggs in the museums of the larger towns so that children might have opportunities of drawing and memorising the eggs; this might do away with the thousands of incomplete and transitory collections which exist at the present time.

It is a very charming and modest account of Winchester College Museum that the Rev. S. A. McDowall contributes to the October issue of the *Museums Journal*. We do not gather from it how much use is made even of the Greek and Roman collections in actual school work, but that the boys out of school-hours are encouraged to take part in curatorial activities appears from the statement that "a collection of local spiders owes its existence to the keenness of a boy still in the school." By leading boys on in this way to take the first steps in research, school museums and school natural history societies may do more than professed classes. Two excellent photographs of the interior of the museum, by a boy in the school, are reproduced as one of the plates. Among much else that is of interest in the varied contents we note a discussion by Mr. E. E. Lowe of the Public Libraries Act of 1919 and its effect on the future policy of (municipal) museums.

In the *Geographical Review* for April–June (vol. ix., No. 4) Dr. V. E. Shelford has a long article, well annotated with bibliographical references, on the aquatic biological resources of the United States. While much attention has been given to water-supply for domestic purposes, to water-power, and to the disposal of sewage, Dr. Shelford points out that other aspects of aquatic resources are more or less neglected. These include, in addition to marine fisheries, freshwater fisheries and mussels, the provision of fish-ways in rivers, the breeding of edible frogs and turtles in swamps and lake-margins, the preservation of insect-destroying birds, and the cultivation of certain aquatic plants of economic value. Dr. Shelford further makes a special plea for the preservation of large swamp areas unless their presence can be shown to be actively detrimental to health. The pollution of rivers and coastal waters is condemned as harmful to natural resources.

The Congo Expedition of the American Museum of Natural History is the subject of a short article, accompanied by a map, in the Bulletin of the museum (vol. xxxix., p. xv.). The expedition, which spent more than six years in the Congo, returned to New York in 1915 with some 20,000 vertebrate and more than 100,000 invertebrate zoological specimens, besides large collections in anthropology and botany. The district explored was in the north-east of the Belgian Congo, from the Aruwimi River to the head-waters of the Welle River. The leader of the expedition was Mr. H. Lang, who was assisted by Mr. J. P. Chapin. It is proposed to publish the results in four series: scientific papers, which will be collected into twelve volumes after appearance in the Bulletin; special memoirs; three ethnological albums; and the narrative of the expedition. As some acknowledgment of the generous co-operation of the Belgian Government in the work of the expedition, it has been decided to present a duplicate set of the collection to the Congo Museum at Tervueren, near Brussels.

THE hall illustrating the "Age of Man" in the American Museum of Natural History, New York, is now approaching completion, and Prof. H. F. Osborn gives some account of it in the journal of the museum, *Natural History* (vol. xx., No. 3). Besides the collection of plaster casts and specimens, there are beautiful wall-paintings by Mr. C. R. Knight, representing scenes in the life of the various races of prehistoric man and of the large mammals by which they were surrounded in different parts of the world. There are also hypothetical bust-restorations of Pithecanthropus, Eoanthropus, Neanderthal man, and Crô-Magnon man; while a completely restored figure of Neanderthal man is now being attempted. Critics may be disposed to think that existing evidence is too slender to justify some of the conclusions about man's ancestry which the exhibition suggests, but there can be no doubt that so attractive a presentation of the subject will stimulate wide interest in it in America.

WE have recently received vol. xvii., part v., of the Annals of the South African Museum, containing two systematic papers, one on the Crustacea, the other on the spiders, of South Africa. The former is the sixth contribution by Mr. K. H. Barnard on the crustacean fauna of South Africa, and deals with further additions to the list of marine Isopoda; 73 species are here recorded, 45 being described as new. The list of South African marine Isopoda now includes about 170 species.

IN his presidential address to the Eugenics Association of America (*Scientific Monthly*, September) Dr. Stewart Paton pleads for a more definite and exact knowledge of man in order that the study of eugenics may be directed on sound lines, and especially points out the importance of the study of the personality—the reactions of the human machine as a whole to the conditions actually met with in life. A body of investigators specially trained in the difficult art of studying the personality—which cannot be judged only from the point of view of the physiologist or psychologist—is essential for future progress.

MISS E. A. FRASER has investigated the pronephros and the early development of the mesonephros in the cat (*Journal of Anatomy*, vol. liv., part iv., July, 1920), and finds that the embryonic excretory system of this animal is one continuous organ, the degenerate anterior end passing posteriorly into the fully developed mesonephros. A pronephric ridge is developed as a thickening of the somatic wall of the intermediate cell-mass. During the formation of this ridge and immediately lateral to it a series of cœlomic chambers becomes cut off from the general body-cavity, each chamber communicating with the body-cavity by a narrow passage. Such chambers do not appear to have been observed previously in a mammal, and it is suggested that they represent vestigial pronephric chambers, each with a peritoneal funnel. They soon undergo a change, and from the region of the eleventh somite backwards they close off from the body-cavity and form an almost solid longitudinal cord, which later becomes divided into a series of vesicles, the central cavity of each of which arises secondarily. Though it is difficult to demonstrate that the longitudinal cord of tissue in which the vesicles arise is actually derived from the pronephric chambers, this interpretation seems to be the correct one. If so, then the pronephric chambers are homologous with the Malpighian capsules.

DURING the course of recent ecological work on the Irish coast—near Dublin and in Galway Bay—collections were made of the mites (Acarina) occurring in the inter-tidal area, and Mr. J. N. Halbert has described the material in a paper published in the Proceedings of the Royal Irish Academy (vol. xxxv., B7, 1920). The species dealt with, which are such as can be reasonably considered as habitual denizens of the inter-tidal area, do not apparently exhibit any striking modifications to suit them for a semi-aquatic life, *e.g.* the breathing organs present no modification. The majority of the species possess, in common with many purely terrestrial species, a smooth, shining epidermis or a covering of hairs, which serves to protect the surface of the mite from becoming wetted. The usual habitat of these mites is in sheltered places—crevices, rock-fissures, and under embedded stones—such as have been for long undisturbed, and where air is imprisoned during high tides. Higher up on the shore, at about high-water mark, a few species have succeeded in establishing themselves where they are only occasionally wetted or sprayed. The zonal distribution of the inter-tidal mites is shown in a table, from which it is seen that below the upper zone, named the orange lichen zone (from the occurrence there of Physcia, Lecanora, etc.), the number of species becomes suddenly much less. The list contains seventy-seven species, twelve of which are new, and a new genus is described.

CLOUDINESS in the United States is the subject of an article by Prof. R. De C. Ward in the *Geographical Review* for April–June (vol. ix., No. 4, 1920). The article contains a useful bibliography of the subject and a new map showing the mean annual cloudiness. The regions of maximum cloudiness appear to be the Great Lakes and the St. Lawrence valley in the east and the northern part of the Pacific Coast in the west. The desert regions in the southwest naturally experience least cloud. Over most of the country the difference between the amount of cloud in the cloudiest and in the least cloudy months is only 10–20 per cent., but in the regions of maximum cloudiness it is 30 per cent. or more, and in the western plateau region it is more than 40 per cent.

THE microscopic examination of the structure of metals and other substances by the aid of light reflected from a polished and etched surface has proved of such great value that Mr. F. E. Wright, of the Geophysical Laboratory of the Carnegie Institution, Washington, has gone carefully into the question as to how far it might be possible by such an examination in polarised light to determine the optical constants of the materials present in the surface. The result of his work is published in No. 7 of the Proceedings of the American Philosophical Society for the current year. Unfortunately, Mr. Wright finds that these constants cannot be satisfactorily found by the method, although there is no difficulty in ascertaining whether the substances seen are crystalline or not by the rotation of the plane of polarisation of plane polarised incident light. Tests of colour, hardness, and behaviour under the action of solvents still remain the most trustworthy for the determination of the substances exposed at the surface.

AMONG the announcements of forthcoming books just issued by the Oxford University Press is one which should appeal especially to readers of NATURE, viz. vol. ii. of "Studies in the History and Method of Science," edited by Dr. C. Singer. The work will contain the following contributions:—Greek Biology and its Relation to the Rise of Modern Biology, Dr. C. Singer; Medieval Astronomy, Dr. J. L. E. Dreyer; Leonardo as Anatomist, H. Hopstock; Science and Hypothesis, Dr. F. C. S. Schiller; The Asclepiadæ and the Priests of Asclepius, E. T. Withington; History of Anatomical Injections, F. J. Cole; The Scientific Works of Galileo, J. J. Fahie; Unity in Modern Scientific Thought, F. S. Marvin; Four Armenian Tracts on the Structure of the Human Body, F. C. Conybeare; Roger Bacon and the State of Science in the Thirteenth Century, R. Steele; A History of Palæobotany, Dr. E. N. A. Arber; Science and Metaphysics, J. W. Jenkinson; and Archimedes' Principle of the Balance and some Criticisms upon it, J. M. Child. The same publishers also promise "A History of Greek Mathematics," by Sir Thomas Heath, in two volumes.

SIR ISAAC PITMAN AND SONS, LTD., have in preparation a new series of Technical Primers, the aim of which is to present a sound technical survey of fundamental facts, principles, equipment, and practice in volumes covering ultimately all phases and branches of technology. The earliest volumes will deal with Continuous-Current Armature Winding, Belts for Power Transmission, Municipal Engineering, Water-Power Engineering, Photographic Technique, Foundrywork, Pattern-Making, Hydro-Electric Developments, The Electric Furnace, Small Single-Phase Transformers, Pneumatic Conveying, The Electrification of Railways, and The Steam Locomotive.

THE Cambridge Pocket Diary for the academic year 1920–21 has been issued by the Cambridge University Press, price 3*s*. In addition to the information usually found in diaries, a complete list of University officials, dates of examinations and of meetings of officials, and local information, such as Cambridge telephone numbers and the train service to London and to Oxford, are included in this convenient little book.

THE United States Coast and Geodetic Survey has published a short list (No. 109) of its publications since January 1, 1914, which is supplied free of charge to those interested. The list includes papers in geodesy, magnetism, cartography, and hydrography.

Our Astronomical Column.

THE ITALIAN ASTRONOMICAL SOCIETY.—This society is commencing the publication of the third series of its Memoirs. Vol. i., No. 1, has just appeared, and contains several papers of interest. The Rev. J. G. Hagen writes on the galaxy and the "Via Nubila"—a name that he suggests for a stream of nebulæ, both luminous and dark, having its maximum density in the well-known nebulous region round the galactic North Pole. G. Armellini contributes a paper on the gravitational potential of the galaxy, and endeavours to explain certain small anomalies in the motion of the planets Saturn and Neptune by stellar perturbations. It is, however, fairly clear that on any reasonable assumption of the mass of the stellar system its differential action within the planetary family must be wholly inappreciable. A. Bemporad publishes a series of comparisons of 32 Geminorum with the neighbouring stars ξ and e Geminorum, made with a wedge photometer between December and March last. It is concluded that the magnitude of 32 Geminorum varies between 6·5 and 7·2 in a period of 2·43 days; the light-curve is not given, but it is stated to be "of the usual type of short-period variables, with a pronounced secondary maximum." E. Bianchi notes that the minor planet (44) Nysa varied in light with a range of half a magnitude in a period of thirty-six days; these observations were made in March and April, 1913. On the other hand, observations in 1920 indicate the much shorter period of $3\frac{1}{4}$ hours; this is presumably an effect of rotation, in which case the monthly variation previously observed needs some other explanation. Other papers deal with the giant and dwarf stars (G. Zappa); measures of the sun's diameter, which appear to show some variation in the value in the course of the sun-spot cycle (A. Prosperi); and stellar spectra with an objective prism (G. Abetti).

THE COLOUR OF NEBULOUS STARS.—Sir W. Herschel discovered 130 years ago that certain stars were surrounded by nebulous envelopes, and made the correct deduction that the latter were gaseous, not stellar. These objects play an important part in theories of cosmogony, and deserve careful study. The *Astrophysical Journal* for July contains a paper by F. H. Seares and E. P. Hubble which establishes the interesting fact that these stars are redder by about one colour-class than would be expected from their spectral type. This was first noted visually by Hubble in one or two cases; a systematic campaign was therefore planned with the Mount Wilson 60-in. reflector, using the method of exposure ratios. About fifty stars were examined, being roughly half of the known objects of this type. Their spectra are mainly of type B, with a few early A's, one Oe5, and one G5. Check stars were photographed at the same altitude to determine the plate constants. The stars mainly lie in two groups, and the mean excess of colour-class for these groups is 1·28 and 0·88. In a few cases where the effect does not appear it is stated that the visual aspect suggests that the star is not really in the nebula, but accidentally projected upon it.

There is a discussion of possible explanations; the most straightforward is that the red colour is produced by molecular scattering in the nebulous envelope. Fluorescence in the nebula near the star's surface is also suggested; alternatively, that the presence of the envelope may have an influence on the star's constitution. It is noted that if the envelope were composed of particles above a certain size, general, and not differential, absorption would result, so that this may explain the non-occurrence of the phenomenon in a few cases.

Ou Conceptions of the Processes of Heredity.*

By MISS E. R. SAUNDERS, F.L.S.

I.

BY the term "inheritance" we are accustomed to signify the obvious fact of the resemblance displayed by all living organisms between offspring and parents, as the direct outcome of the contributions received from the two sides of the pedigree at fertilisation; to indicate, in fact, owing to lack of knowledge of the workings of the hereditary process, merely the *visible* consequence—the final result of a chain of events. Now, however, that we have made a beginning in our analysis of the stages which culminate in the appearance of any character, a certain looseness becomes apparent in our ordinary use of the word "heredity," covering as it does the two concomitant essentials, genetic potentiality and somatic expression—a looseness which may lead us into the paradoxical statement that inheritance is wanting in a case in which, nevertheless, the evidence shows that the genetic constitution of the children is precisely like that of the parents. When we say that a character is inherited no ambiguity is involved, because the appearance of the character entails the inheritance of the genetic potentiality. But when a character is stated not to be inherited it is not thereby indicated whether this result is due to environmental conditions, to genetic constitution, or to both causes combined. That we are now able in some measure to analyse the genetic potentialities of the individual is due to one of those far-reaching discoveries which change our whole outlook, and bring immediately in their train a rapidly increasing array of new facts, falling at once into line with our new conceptions, or by some orderly and constant discrepancy pointing a fresh direction for attack.

The earliest attempts to frame some general law which would co-ordinate and explain the observed facts of inheritance were those of Galton and Pearson. These schemes, however, take no account of the physiological nature of this as of all other processes in the living organism. They have, in consequence, failed to bring us nearer to our goal—a fuller comprehension of the workings of the hereditary mechanism. Progress in this direction has resulted from the method of inquiry which deals with the unit in place of the mass. The revelation came with the opening of the present century, for in 1900 was announced the rediscovery of Mendel's work, actually given to the world thirty-five years earlier, but at the time leaving no impress upon scientific thought. It chanced that in each pair of characters selected by Mendel for experiment the opposites are related to each other in the following simple manner: An individual which had received both allelomorphs, one from either parent, exhibited one of the two characteristics, hence called the dominant, to the exclusion of the other. Among the offspring of such an individual both characteristics appeared, the dominant in some, its opposite, the recessive, in others, in the proportion approximately of three to one. This is the result which might be expected from random pairing in fertilisation of two opposites, where the manifestation in the zygote of the one completely masks the presence of the other. As workers along Mendelian lines increased and the field of inquiry widened, it soon, however, became apparent that the dominant-recessive relationship is not of universal occurrence. It likewise became clear that the simple ratios which obtained in Mendel's experiments are not characteristic of every case. Mendel's own results were all, as it happened, explicable on the supposition that the two alternative forms of each character were dependent on a *single* element or factor. We now know, however, that many characters are not controlled by one single factor, but by two or more. One of the most familiar instances of the two-factor character is the appearance of the colouring matter anthocyanin in the petals of plants such as the stock and sweet pea. Our proof that two factors (at least) are here involved is obtained when we find that two true breeding forms devoid of colour yield coloured offspring when mated together. In this case the two complementary factors are carried, one by each of the two crossed forms. When both factors meet in the one individual, colour is developed. We have in such cases the solution of the familiar, but previously unexplained, phenomenon of reversion. Confirmatory evidence is afforded when among the offspring of such cross-bred individuals we find the simple 3 to 1 ratio of the one-factor difference replaced by a ratio of 9 to 7. Similarly, we deduce from a ratio of 27 to 37 that three factors are concerned, from a ratio of 81 to 175 four factors, and so on. The occurrence of these higher ratios proves that the hereditary process follows the same course whatever the number of factors controlling the character in question.

And here I may pause to dwell for a moment upon a point of which it is well that we should remind ourselves from time to time, since, though tacitly recognised, it finds no explicit expression in our ordinary representation of genetic relations. The method of factorial analysis based on the results of inter-breeding enables us to ascertain the least possible number of genetic factors concerned in controlling a particular somatic character, but what the total of such factors actually is we cannot tell, since our only criterion is the number by which the forms we employ are found to differ. How many may be common to these forms remains unknown. In illustration I may take the case of surface character in the genera Lychnis and Matthiola. In *Lychnis vespertina* the type form is hairy; in the variety *glabra*, recessive to the type, hairs are entirely lacking. Here all glabrous individuals have so far proved to be similar in constitution, and when bred with the type give a 3 to 1 ratio in F_2 (Report to the Evolution Committee, Royal Society, i., 1902). We speak of hairiness in this case, therefore, as being a one-factor character. In the case of *Matthiola incana* v. *glabra*, of which many strains are in cultivation, it so happened that the commercial material originally employed in these investigations contained all except one of the factors since identified as present in the type and essential to the manifestation of hairiness. Hence it appeared at first that here also hairiness must be controlled, as in Lychnis, by a single factor. But further experiment revealed the fact that though the total number of factors contained in these glabrous forms was the same, the respective factorial combinations were not identical. By interbreeding these and other strains obtained later, hairy F_1 cross-breds were produced giving ratios in F_2 which proved that at least four distinct factors are concerned (Proc. Roy. Soc., B, vol. lxxxv., 1912). Whereas, then, the glabrous appearance in Lychnis always indicates the loss (if for convenience we may so represent the nature of the recessive condition) of

* From the opening address of the President of Section K (Botany) delivered at the Cardiff meeting of the British Association on August 24.

one and the same factor, analysis in the stock shows that the glabrous condition results if *any factor out of a group of four* is represented by its recessive allelomorph. Hence we describe hairiness in the latter case as a four-factor character.

It will be apparent from the cases cited that we cannot infer from the genetic analysis of one type that the factorial relations involved are the same for the corresponding character in another. That this should be so in wholly unrelated plants is not, perhaps, surprising, but we find it to be true also where the nature of the characteristic and the relationship of the types might have led us to expect uniformity. This is well seen in the case of a morphological feature distinctive of the N.O. Gramineæ. The leaf is normally ligulate, but individuals are occasionally met with in which the ligule is wanting. In these plants, as a consequence, the leaf-blade stands nearly erect instead of spreading out horizontally. Nilsson-Ehle ("Kreuzungsuntersuchungen an Hafer und Weizen," Lund, 1909) discovered that in oats there are at least four, and possibly five, distinct factors determining ligule formation, all with equal potentialities in this direction. Hence, only when the complete series is lacking is the ligule wanting. In mixed families the proportion of ligulate to non-ligulate individuals depends upon the number of these ligule-producing factors contained in the dominant parent. Emerson (Annual Report of the Agricultural Experiment Station of the University of Nebraska, 1912) found, on the other hand, that in maize mixed families showed constantly a 3 to 1 ratio, indicating the existence of only one controlling factor.

From time to time the objection has been raised that the Mendelian type of inheritance is not exhibited in the case of specific characters. That no such sharp line of distinction can be drawn between the behaviour of varietal and specific features has been repeatedly demonstrated. As a case in point, and one of the earliest in which clear proof of Mendelian segregation was obtained, we may instance Datura. The two forms, *D. stramonium* and *D. tatula,* are ranked by all systematists as distinct species. Among other specific differences is the flower colour. The one form has purple flowers, the other pure white. In the case of both species a variety *inermis* is known in which the prickles characteristic of the fruit in the type are wanting. It has been found that in whatever way the two pairs of opposite characters are combined in a cross between the species, the F_2 generation is mixed, comprising the four possible combinations in the proportions which we should expect in the case of two independently inherited pairs of characters, when each pair of opposites shows the dominant-recessive relation. Segregation is as sharp and clean in the specific character flower colour as in the varietal character of the fruit.

Among the latest additions to the list of specific hybrids showing Mendelian inheritance, those occurring in the genus Salix are of special interest, since heretofore the data available had been interpreted as conflicting with the Mendelian conception. The recent observations of Heribert-Nilsson ("Experimentelle Studien über Variabilität, Spaltung, Artbildung und Evolution in der Gattung Salix," 1918) show that those characters which are regarded by systematists as constituting the most distinctive marks of the species are referable to an extremely simple factorial system, and that the factors mendelise in the ordinary way. Furthermore, these specific-character factors control not only the large constant *morphological features,* but also *fundamental reactions* such as those determining the condition of physiological equilibrium and vitality in general. In so far as any distinction can be drawn between the behaviour of factors determining the varietal as opposed to the specific characters of the systematist, Heribert-Nilsson concludes that the former are more localised in their action, while the latter produce more diffuse results, which may affect almost all the organs and functions of the individual, and thus bring about striking alterations in the general appearance. *S. caprea,* for example, is regarded as the reaction product of two distinct factors which together control the leaf-breadth character, and also affect, each separately and in a different way, leaf form, leaf colour, height, and the periodicity of certain phases. We cannot, however, draw a hard-and-fast line between the two categories. The factor controlling a varietal characteristic often produces effects in different parts of the plant. For example, the factors which lead to the production of a coloured flower no doubt also in certain cases cause the tinging seen in the vegetative organs, and affect the colour of the seed. Heribert-Nilsson suggests that fertility between species is a matter of close similarity in genotypic (factorial) constitution rather than of outward morphological resemblance. Forms sundered by the systematist on the ground of gross differences in certain anatomical features may prove to be more akin, more compatible in constitution, than others held to be more nearly related because the differentiating factors happen to control less conspicuous features.

Turning to the consideration of the more complex types of inheritance already referred to, we find numerous instances where a somatic character shows a certain degree of coupling or linkage with another perhaps wholly unrelated character. This phenomenon becomes still further complicated when, as is now known to occur fairly frequently, somatic characters are linked also with the sex character. The results of such linkages appear in the altered proportions in which the various combinations of the several characters appear on cross-breeding. Linkage of somatic characters can be readily demonstrated in the garden stock. Some strains have flowers with deeply coloured sap, *e.g.* full red or purple; others are of a pale shade, such as a light purple or flesh colour. In most commercial strains the "eye" of the flower is white owing to absence of colour in the plastids, but in some the plastids are cream-coloured, causing the sap colour to appear of a much richer hue and giving a cream "eye." Cream plastid colour is recessive to white, and the deep sap colours are recessive to the pale. When a cream-eyed strain lacking the pale factor is bred with a white-eyed plant of some pale shade, the four possible combinations appear in F_2, but not, as we should expect in the case of two independently inherited one-factor characters, in the proportions 9 : 3 : 3 : 1, with the double recessive as the least abundant of the four forms. We find instead that the double dominant and the double recessive are both in excess of expectation, the latter being more abundant than either of the combinations of one dominant character with one recessive. The two forms which preponderate are those which exhibit the combinations seen in the parents, the two smaller categories are those representing the new combinations of one paternal with one maternal characteristic. In the sweet pea several characters are linked in this manner, viz. flower colour with pollen shape, flower colour with form of standard, pollen shape with form of standard, colour of leaf axil with functioning capacity of the anthers. If in these cases the cross happens to be made in such a way that the two dominant characters are brought in one from each side of the pedigree instead of both being contributed by one parent, we get again a result in which the two parental combinations occur more frequently, the two recombinations or "cross-overs" less often than we should expect. In the first case the two characters appear to hang together in descent to a certain extent, but not completely; in the latter, similarly to repel each other.

This type of relationship has been found to be of very general occurrence. The linked characters do not otherwise appear to be connected in any way that we can trace, and we therefore conclude that the explanation must be sought in the mechanism of distribution. Two main theories having this fundamental principle as their basis, but otherwise distinct, have been put forward, and are usually referred to as the *reduplication* and the *chromosome* view respectively. The reduplication view, proposed by Bateson and Punnett (Proc. Roy. Soc., 1911), rests on the idea that segregation of factors need not necessarily occur simultaneously at a particular cell-division. The number of divisions following the segregation of some factors being assumed to be greater than those occurring in the case of others, there would naturally result a larger number of gametes carrying some factorial combinations and fewer carrying others. If this differential process is conceived as occurring in an orderly manner it would enable us to account for the facts observed. It has, however, to be said that we cannot say *why* segregation should be successive, nor at what moments, on this view, it must be presumed to occur. On the other hand, the conceptions embodied in the chromosome hypothesis as formulated by Morgan and his fellow-workers ("The Mechanism of Mendelian Heredity" (Morgan, Sturtevant, Muller, and Bridges), 1915) are, in these respects, quite precise. They are built around one cardinal event in the life-cycle of animals and plants (some of the lowest forms excepted), viz. the peculiar type of cell-division at which the number of chromosomes is reduced to half that to be found during the period of the life-cycle extending backwards from this moment to the previous act of fertilisation. In the large number of cases already investigated the chromosome number has been found, as a rule, to be the same at each division of the somatic cells. We can, in fact, take it as established that it is ordinarily constant for the species.

These observations lend strong support to the view that the chromosomes are persistent structures—that is to say, that the chromatin tangle of the resting nucleus, whether actually composed of one continuous thread or not, becomes resolved into separate chromosomes at corresponding loci at each successive mitosis. The reduction from the diploid to the haploid number, according to the more generally accepted interpretation of the appearances during the meiotic phase, is due to the adhering together in pairs of homologous chromosomes, each member of the set originally received from one parent lying alongside and in close contact with its mate received from the other. Later, these bivalent chromosomes are resolved into their components so that the two groups destined one for either pole consist of whole dissimilar chromosomes, which then proceed to divide again longitudinally to furnish equivalent half chromosomes to each of the daughter nuclei.

The obvious close parallel between the behaviour of the chromosomes—their pairing and separation—and that of Mendelian allelomorphs which similarly show pairing and segregation, first led to the suggestion that the factors controlling somatic characters are located in these structures. The ingenious extension of this view which has been elaborated by Morgan and his co-workers presumes the arrangement of the factors in linear series after the manner of the visible chromomeres—the beadlike elements which can be seen in many organisms to compose the chromatin structure—each factor and its opposite occupying corresponding loci in homologous chromosomes. From this conception follows the important corollary of the segregation of the factors during the process of formation and subsequent resolution of the bivalent chromosomes formed at the reduction division. We should suppose, according to Morgan, in the case of characters showing *independent* inheritance and giving identical Mendelian ratios whichever way the mating is made and however the factorial combination is brought about, that the factors controlling the several characters are located in *different* chromosomes. Thus in the case of Datura already mentioned the two factors affecting sap-colour and prickliness respectively would be presumed to be located so far apart in the resting chromatin thread that when separation into chromosomes takes place they become distributed to different members. Where unrelated characters show a *linked* inheritance the factors concerned are held, on the other hand, to lie so near together that they are always located in one and the same chromosome. Furthermore—and here we come to the most debatable of the assumptions in Morgan's theory—when the bivalent chromosome composed of a maternal and a paternal component gives rise at the reduction division to two single dissimilar chromosomes, these new chromosomes do not always represent the original intact maternal and paternal components. It has been observed in many forms that the bivalent structure has the appearance of a twisted double thread.

Already in 1909 cytological study of the salamander had led Janssen (*La Cellule*, xxv.) to conclude that fusion might take place at the crossing points, so that when the twin members ultimately draw apart each is composed of alternate portions of the original pair. Morgan explains the breeding results obtained with Drosophila by a somewhat similar hypothesis. He also conceives that in the process of separation of the twin lengths of chromatin cleavage between the two is not always clean, portions of the one becoming interchanged with corresponding segments of the other, so that both daughter chromosomes are made up of complementary sections of the maternal and paternal members of the duplex chromosome. On the main issue, however, both schemes are in accord. A physical basis for the phenomenon of linkage is found in the presumed nature and behaviour of the chromosomes, viz. their colloidal consistency, their adhesion after pairing at the points of contact when in the twisted condition, and their consequent failure to separate cleanly before undergoing the succeeding division.

According to Morgan, the frequency of separation of linked characters is a measure of the distance apart in the chromosome of the loci for the factors concerned, and it becomes possible to map their position in the chromosome relatively to one another. In this attempt to find in cytological happenings a basis for the observed facts of inheritance, our conception of the material unit in the sorting-out process has been pushed beyond the germ-cell, and even the entire chromosome, to the component sections and particles of the latter structure.

To substantiate the "chromosome" view the primary requisite was to obtain proof that a particular character is associated with a particular chromosome. With this object in view it was sought to discover a type in which individual chromosomes could be identified. Several observers working on different animals found that a particular chromosome differing in form from the rest could be traced at the maturation division, and that this chromosome was always associated with the sex-character in the following manner. The female possessed an even number of chromosomes so that each egg received an identical number, including this particular sex-chromosome. The male contained an uneven number, having one fewer than the female, with the result that half the sperms received the same number as the egg including the sex-chromosome, and half were deficient in this particular chromosome. Eggs fertilised with sperms containing the full number of chromosomes developed into females, while those fertilised with sperms lacking this distinctive chromosome produced males. Morgan made the further discovery in the fruit-fly, *Drosophila ampelophila*, that certain factors controlling various somatic characters were located in the sex-chromosome. The inheritance of these characters and of sex evidently went together. The sperms of Drosophila are therefore conceived as of two kinds, one containing the same sex-chromosome as the eggs, the so-called X chromosome, and the other a mate of a different nature, the Y chromosome, which appears to be inert and unable to carry the dominant allelomorphs.

Instances of sex-linked inheritance are now known in many animals, some of which are strictly comparable with Drosophila; others follow the same general principle, but have the relations of the sexes reversed, as exemplified by the moth Abraxas, which has been worked out by Doncaster (Rep. Evolution Committee, iv., 1908), whose sudden death we have had so recently to deplore. Here the female is the heterozygous sex, and contains the dummy mate of the sex-chromosome.

(*To be continued.*)

The Department of Scientific and Industrial Research.

By J. W. WILLIAMSON.

THE Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1919–20[1] is of great interest to all those who are watching with sympathetic anxiety the attempt, embodied in the Department of Scientific and Industrial Research, to secure greater and better organised State aid for scientific research without subjecting the research worker to such Governmental control as would stifle his spirit and energies. The present report is the Committee's fifth annual report, and the Report of the Advisory Council which is subjoined, before proceeding to record the past year's work, takes the occasion to give a brief survey of its labours during the past five years.

The Government has entrusted to the Department during the past year new responsibilities. The Geological Survey and Museum of Practical Geology were transferred to the Department on November 1 last, and a Geological Survey Board has been appointed under the chairmanship of Sir Francis Ogilvie. At the beginning of this year the Cabinet decided that means should be adopted so to organise the scientific work that was needed for the fighting Services as to avoid unnecessary overlapping, to secure the utmost economy of *personnel* and equipment, to facilitate the interchange of scientific knowledge and experience between all the Departments concerned, and to provide a single direction and financial control for all work of a fundamental nature of civilian as well as military interest. It directed that the Department should establish a series of co-ordinating Boards, and that these Boards should include technical representatives of each of the fighting Services and of such civilian Departments as might be materially interested in their work, as well as independent men of science. Three Boards, one for chemistry, one for physics, and one for engineering, have been established, and these, with the existing Radio Research Board, form the nucleus of the scheme. These new arrangements are, obviously, an attempt to apply the principles of the co-operative conduct of research to Government Departments, and as the Advisory Council points out: "If firms competing with each other for existence can combine, as they have done, for their common benefit, it ought not to be more difficult for the members of a national service to do so merely because they are attached to different Departments of the Government."

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1919–20. (Cmd. 905.) Pp. 120. (London: H.M. Stationery Office.) Price 1*s*. net.

The review of the past five years' work of the Department is a satisfying and promising record. The programme, it is explained, falls under four main heads: (1) The encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; and (4) the aiding of suitable researches undertaken by scientific and professional societies and organisations.

Since the establishment of the Department, 136 maintenance grants have been made to students and 89 to independent workers, while 48 grants have been made to provide professors with research assistants of scientific standing. During the four academic years in which grants could be made, approximately 50,000*l*. was distributed in grants of the various kinds referred to, and it is anticipated that during the next academic year the distribution will amount to about 45,000*l*. The great majority of the grants have been made for work in the fundamental sciences. The Advisory Council goes on to say: "And here a word of explanation is needed in view of ill-informed criticism of our policy. No conditions are attached to the grants made to workers whose sole aim is the extension of knowledge, either as to the line of their work or as to the use to be made of the results. If they propose to make commercial use of their discoveries we require them to consult us, because at this point they are leaving the field of pure investigation. But, subject to this single condition, their tenure is as free as, and in some respects more free than, that of a scholarship, fellowship, or professorship."

With respect to the organisation of industries into research associations, the present position is that eighteen research associations have been established, and that five others have been approved by the Department and will shortly receive their licences from the Board of Trade. Of the 1,000,000*l*. fund it is estimated that the Department is committed at the present time to a total expenditure of nearly 450,000*l*. on account of the established research associations, and to a further expenditure of at least 120,000*l*. on account of those approved but not yet licensed. The total commitments out of the 1,000,000*l*. fund are expected shortly to reach 800,000*l*., and the report observes: "It is clear that the sum placed at our disposal is not likely to be more than sufficient to aid the associations either formed or likely to be formed." There is much sanity in the reply of the Advisory Council to the criticism, actual or hypothetical, that much greater scientific results of value to industry would have been produced if the 1,000,000*l.* had been spent directly upon research done at the National Physical Laboratory and other research laboratories up and down the country. "Had the million been spent on research directed by the Government itself, its effect upon manufacturers would at the best have been destructive of their self-reliance, and at the worst a free gift to their competitors in other lands." We agree. Critics of this side of the Department's activities do not seem to recognise that to throw responsibility for research on the industries themselves is the surest way to educate the industries to appreciate the difficulty and the value of research.

A word may well be said here as to the statement in the report that at the end of the five years' period the research associations "must be prepared to continue without subvention from the State." The general principle is undoubtedly sound, and in the case of industries with large aggregations of capital there need be little fear that, having set their hands to the plough, they will turn back when the support of the State fails. For them the five years is probably a sufficient period. But there are industries, relatively small when measured either by the capital available or even by their production, which are, nevertheless, of vital importance to the State—"key" industries from their character rather than from their size. For these it may be necessary that State aid should be prolonged for more than the five years' period if, for them, the benefits of this research movement are to be consolidated and extended.

On the question of the conduct and co-ordination of national research the report truly observes that if the scheme for co-operative research in the several industries is to be a permanent success, provision must also be made for dealing with certain fundamental problems which are of such wide application that no single industry, however intelligent or highly organised, could hope to grapple with them effectively. The first of these basic problems is fuel. The Fuel Research Board was appointed in 1917 under the directorship of Sir George Beilby. A brief account of the activities of this Board is given. It includes such questions as "Gas Standards and the Development of the Gas Industry," "Peat as a Source of Fuel," "Pulverised Fuel," and problems of the production and utilisation of alcohol for power and traction purposes. Other instances of these "national researches" briefly reviewed in the report are the conservation of coal and mineral resources, the preservation of food, and the research into building materials and construction.

In the section dealing with the aiding of suitable researches undertaken by scientific and professional societies and organisations it is stated that grants have been made for the work on hard porcelain at the Stoke-on-Trent Central School of Science and Technology, that on glass technology at Sheffield University, and that on technical optics at the Imperial College of Science and Technology.

In concluding its short summary of the first five years' work the Advisory Council well says: "A longer period for review is specially necessary in our case, for research cannot be expected to produce results at short and regular intervals. Indeed, the expectation that it will is a misconception which has stood largely in the way of its consistent use by manufacturers, and has strained the patience of a public apt to think that the placing of an Act upon the Statute Book and the creation of a new organisation are all that is necessary to reach a desired end. If art is long in comparison with life, science, in spite of all its brilliant achievements, is longer still." That truth needs to be ever in the minds of those who deal with research.

The University of Birmingham.

ON Friday last, October 8, a number of influential representatives of Birmingham and the Midlands were the guests of the University of Birmingham at a luncheon in the Great Hall of the University at Edgbaston. The Chancellor (Lord Robert Cecil) presided, and the object of the gathering was to make known the need for increased financial assistance for the University.

Funds are urgently needed "to extinguish the debt of the University (130,000*l.*); to pay the staff of the University a living wage; to provide the necessary new accommodation and staff for the existing departments of science, arts, medicine, commerce, and education; to provide in all faculties facilities for research urgently needed in the public interest; to meet the greatly increased cost of administration and upkeep; and to enable the University to maintain its position among modern universities."

The Chancellor in calling upon Mr. Austen Chamberlain to speak welcomed him as one of the Members of Parliament for Birmingham, as Chancellor of the Exchequer, and more than all as the son of his father. Mr. Chamberlain, speaking first as a citizen of Birmingham, outlined the history of the civic expansion of the city in the days of his father, when the strenuous efforts of the leading men succeeded in making Birmingham a worthy metropolis of the Midlands, their work culminating in the foundation of the University. Speaking for the Government, he gave expression to the surprise with which they had learned the extent to which the country had been dependent upon university learning for success in the Great War. Now he "would say to an audience drawn from a great business community centring in Birmingham that if such services can be rendered by university learning in war-time, is it not certain that those services are equally necessary to our prosperity as a nation, and the prosperity of this city and district, amidst the difficulties and developments which have followed on the restoration of peace? Upon the recognition as a great community of the national and civic importance of such an institution as the University depends the ability to hold our place among the cities of the kingdom and the Empire."

The Government was fully aware of the immense importance of universities, and ready to back its opinion of that importance. It had spent for many years immense sums on elementary education; it had spent considerable sums on secondary education; but all too little on university education. Mr. Chamberlain had undertaken, unless he was prevented by overwhelming financial reasons, to submit to Parliament for next year a grant of 1,500,000*l.*, and he had undertaken to consider—and though he could not promise, he hoped he might be able to do something in that direction—a further special non-recurrent grant in order to adapt the federated universities' scheme of pensions to the case of the older men who had joined and served the universities long before that scheme was in existence, and therefore on retirement would, without extraneous aid, receive only the smallest pittance from it. He hoped the grant would be on that basis for a term of years. What the University of Birmingham would get out of this depended on Sir William M'Cormick's Committee, which would advise the Government. He attached great importance to the advice of that Committee on the administration of the grant. "The less Government interference the better. Whatever you do, don't sacrifice your independence; don't come to that condition, one of those which brought Germany to her ruin." Professors of universities must be independent men, free to express their individual thoughts, subject to such control as the Chancellor or the authorities of the University might think right to impose on them. He did not want direct Government control or interference; he did not want party "pull"; he did not want anything to govern the grant except the relative merits of the recipients. Therefore he attached great importance to the independent Committee of Sir William M'Cormick, which had secured the confidence of every University which it was called upon to examine, and had been a real friend and of real assistance to those universities.

The Government had laid down general lines for the guidance of that Committee. In the first place, it could not encourage any university to undertake new developments before it had made adequate provision for that which already existed. If any grants are expected in respect of new developments, it must approve these new developments as being suitable to the general scope of the university in which they are proposed. Moreover, the work done must be of university standard. Finally, the grant would depend on the amount of local support given by the city and the Midlands. "If the citizens of Birmingham, if the towns and counties round, do not care enough for their University, and all that it means to them, to give it adequate local support, then whatever the Member for West Birmingham might be allowed to say, the Chancellor of the Exchequer will tell you flatly that if you do not value your Midland University you cannot expect the taxpayer at large to pay for conveniences for you to which you yourselves will not contribute." He most earnestly hoped that the citizens of Birmingham, and the counties and boroughs which surrounded them, would co-operate to make the University a common source of learning and of wealth for them all.

The Principal (Mr. C. Grant Robertson) read a letter from the President of the Board of Education, who wished success to the appeal, and remarked that "all over the country we are faced with the paradox that while the nation has never derived more benefit from its universities, these institutions have never found it more difficult to carry on their existence."

Mr. Grant Robertson pointed out that 42 per cent. of the students of the University came from Birmingham itself, 42 per cent. from the region round about, and the remainder from distant parts, and he hoped that the surrounding districts would contribute accordingly; at present their contribution was not one-tenth of that given by the City of Birmingham. He emphasised the underpayment of the staff; he believed that there was not one of them who could not double his income by leaving the University at that moment. By what moral right did we expect gifted men to give services at a wage which in industry would be regarded as contemptible? Professors could no more be improvised than admirals or generals. Facilities for research were indispensable; a university in which research did not flourish was a crippled institution. There was, too, a growing and insistent demand for extra-mural work that ordinary men and women might benefit. This demand must be met, but it could not be met without money. It was a most promising sign that the people were turning to the university to learn the duties and solve the problems of citizenship. They were asking for instruction in subjects which went to the root of civic life—history, political theory, economics, and civics—and by giving this instruction the universities would be doing much to make democracy safe for the world.

The problems of the present and near future were commonly called economic; they were really spiritual and moral, and they could not be solved by merely material remedies. We were victors in the war, and our universities might be made potent instruments in the spiritual, moral, and intellectual reconstruction of society. This might be an inauspicious time for an appeal, but the University was faced with a crisis; it must either act or succumb.

In the evening the Lord Mayor (Alderman William Cadbury) presided over a meeting in the Town Hall. Lord Robert Cecil made an eloquent appeal, showing the discreditable state of this country in the matter of university education as compared with the United States, with Germany, and, most of all, with Scotland. It was a curious fact that in England people seemed to think that anyone could use his mind without special training. This was a grave fallacy, and a university was essential to provide the necessary mental training which was so vital to us as a nation. With the increasing responsibility which was being thrust upon the people (in foreign politics, for example), it was of the utmost importance that the working classes should have full opportunities of receiving education, and especially university education.

Mr Neville Chamberlain, M.P., appealed especially to the manufacturers, banks, insurance companies, and others dependent on industry for their money. He contrasted the business methods of forty years ago with those of the present, showing that to-day—when even directors are supposed to know something of the business they direct—a constant supply of highly trained young men such as the University of Birmingham can provide is an essential factor in the success of our national commerce. If it paid men to invest large sums of money in securing the raw materials of their business, it must pay them even more to invest a modest sum in maintaining the efficiency of an institution which turns out brains—quite as important as raw materials in the success of a business.

A resolution—"That this meeting, recognising the importance of the University of Birmingham in the commercial, intellectual, and social life of the Midlands, and convinced of its need for greatly enlarged funds, cordially supports the appeal now to be issued"—was carried unanimously.

At the close of the meeting the Pro-Vice-Chancellor (Alderman Clayton) announced that a sum of 200,000*l.* had been conditionally promised.

Aeronautics at the Science Museum, South Kensington.

THE collection of aeronautics in the Science Museum has been recently rearranged, and now occupies one of the galleries of the new Science Museum Buildings in Exhibition Road, South Kensington. Many important additions have been made to it, so that visitors can study the development of aeronautics from early times in the many objects of great historical interest, while the progress made in aviation during the last six years is represented by numerous exhibits which have been recently acquired.

The collection is arranged in six sections: Aeroplanes and aeroplane models, aeroplane construction, engines, instruments, experimental apparatus, and ballooning.

In the first of these an object of especial historical interest is the Henson flying machine model of 1842–45, which bears a striking resemblance to the modern monoplane, but was doomed to failure chiefly on account of the lack of a light engine of high power. Early pioneer work in gliding is illustrated by Lilienthal's glider, similar to the one on which the inventor met his death in 1896.

The development of the modern aeroplane can be followed in the series of scale models by which the machines of the Brothers Wright, Voison, Farman, Blériot, Santos-Dumont, and the German Taube are represented. Among the full-size machines are the only existing machine of Cody and the Vickers-Vimy Rolls-Royce aeroplane which crossed the Atlantic last year.

In the section devoted to aeroplane construction are examples of historical and modern propellers, and actual portions of early and modern aeroplanes in which the methods of construction may be compared. Portions of an early Wright biplane have been preserved, and the visitor can operate and study the control mechanism of this machine.

The collection of aeroplane engines ranges from the early steam engines of Henson and Maxim to the modern high-power petrol engine, and the collection of engines of types used during the war, including British, French, Italian, as well as German, models, is of great interest.

A wind-channel and a water-channel for experimental work may be seen in operation; the principal instruments used in aerial navigation and reconnaissance are also shown. Balloons and airships are not as yet fully represented, but to all sections additions are continually being made.

University and Educational Intelligence.

CAMBRIDGE.—An extension of the metallurgical department of the chemical laboratory, provided by the generosity of the Goldsmiths' Company, was opened on October 5 by the Prime Warden. It includes rooms for the study of high temperatures, general metallographic research, assaying of gold and silver and their ores, a balance-room, and general provision for students working at analytical and general metallurgy.

E. K. Rideal has been elected a fellow of Trinity Hall, and H. Glauert and A. D. Ritchie fellows of Trinity.

WE learn from *Science* for September 17 that the University of Buffalo has received from O. E. Foster a gift of 400,000 dollars for the erection of a chemistry building. It has also received anonymous gifts of 250,000 dollars towards endowment and of a library building.

A COURSE of ten public lectures on "Medieval Contributions to Modern Civilisation" will be delivered at King's College, London, during the present term on Wednesdays at 5.15. Philosophy will be dealt with on October 27 by Prof. H. Wildon Carr, and Science on November 3 by Dr. Charles Singer. Other subjects are Religion, Art, Literature, Education, Society, Economics, and Politics.

THE *Pioneer Mail* for September 17 states that the Bill to establish and incorporate a Moslem university at Aligarh has been passed by the Imperial Legislative Council. The Viceroy congratulated the Mohammedan community on the new institution, and several Mohammedan members expressed their thanks to his Excellency for his interest in the provision of educational facilities for their community.

IN a public address delivered during the course of the recent second annual conference of the Reading and District Teachers' Association, Mr. H. A. L. Fisher, President of the Board of Education, stated some facts relative to the cost of education. In the last two years the net total expenditure has risen from 19¼ millions to 45⅝ millions, *i.e.* the cost of education has been more than doubled. The largest part of this increase is represented by additions to the salaries of teachers, of whom there are now nearly 200,000 in the public service. The additions to salaries amount to 130 per cent. increase on pre-war salaries, while the cost of living during the same period has risen by 152 per cent.; this increases the cost per child by 119 per cent. Before the war, local education authorities bore 53 per cent. of the expenses incurred, and the Board of Education 47 per cent.; now the position is exactly reversed. Mr. Fisher is of opinion that developments under the Education Act of 1918 and the cost of putting into effect the recommendations of the two Burnham Committees which are now sitting will give rise to a steady increase in the cost of education.

THE report of the University of Leeds for the year 1918–19 has been received. Full lists are given of the professorial and executive staff, before entering upon the report proper, which, it is worth noting, is the fifteenth which has been issued since the charter was acquired in 1904. It reviews the growth of the University from the autumn of 1918 to the spring of 1920, although the statistics and accounts are mostly confined to the session 1918–19. During the period under review the number of students taking full-time courses has been doubled; unfortunately, only one-sixth of this number enjoy collegiate life in the limited number of hostels available. The financial strain caused by the increased demand for higher education bears heavily on the University, and in consequence an appeal for 500,000*l.* has been issued. During the war more than fifteen hundred members served in his Majesty's forces, and some five hundred casualties were sustained. The head of the chemical department acted as chief chemical adviser to the Home Forces, and other members of the faculty undertook the responsible duties of testing varnishes, of manufacturing antiseptics and drugs, of testing high explosives, etc. The leather, engineering, textile industries, and colour chemistry departments also took active parts in researches instituted by the Government. Among the grants which have been made to the University, the most important is a sum of 36,000*l.* from the Treasury as an annual grant, and a further non-recurrent sum of 9000*l.* for the session 1920–21. An annual grant of 3800*l.* for five years has also been made towards the maintenance of the School of Agriculture. A number of friends of the late Sir Swire Smith from Keighley and district have raised the sum of 3000*l.* for the endowment of a fellowship, open to graduates of any faculty, for the purpose of conducting research. The remainder of the report is devoted to a statement of the deaths, resignations, and appointments of University officials. Towards the end of the report each department is taken separately, and an account of its work during the past academic year given.

Societies and Academies.

PARIS.

Academy of Sciences, September 20.—M. Léon Guignard in the chair.—H. **Lecomte**: The radial secretory canals of wood. The usual direction of these canals in the tissues of the stem and root is parallel to the length of the organ, but a system of radial secretory canals may, in a large number of plants, be superimposed on the longitudinal system. These radial canals have been noted by Trécul and others, but have hitherto been regarded as exceptional cases. In the genera Pinus, Picea, and Larix the radial canals are now found to be present in all cases, and numerous examples were also found in other species.—P. **Humbert**: Hypercylindrical functions in space of $n+2$ dimensions.—J. **Soula**: Remarks on the investigation of the singular points of a function defined by a development in Taylor's series.—J. **Andrade**: The geometrical interpretation of the Résal-Caspari method.—A. **Véronnet**: Values of the flattening of the earth obtained by calculation and by measurement.—A. **Buhl**: The formula of Stokes in space-time.—M. **Flajolet**: Perturbations of the magnetic declination at Lyons during the second half of 1919 and the first half of 1920. The observations are tabulated in six groups between calm days and perturbations greater than 30′. On August 11, 1919, and March 4, 1920, the disturbances were very large and outside the scale of the recorder.—H. **Coupin**: The resistance of seedlings to starvation. The seedlings of seventeen species of plants grown in the dark in distilled water lived from fifteen to sixty days.—F. **Vlès**: The production of difference spectra of toxin cultures. Further study of the changes produced in the absorption spectra of toxin cultures by heating and by the addition of antitoxin.—C. **Lebailly**: The prevention and treatment of aphthous fever by the serum or blood of cured animals. Experiments were made on more than five hundred animals. The immunity produced by the injection was of very short duration, in some cases less than fifteen days. Good results were obtained in the treatment of infected animals, provided that the injections were made as soon as possible after the disease was recognised.

CAPE TOWN.

Royal Society of South Africa, August 18.—Dr. A. Ogg, vice-president, in the chair.—P. A. **van der Bijl**: Note on *Lysurus Woodii* (MacOwan), Lloyd. The fungus described was found in a rhubarb trench in Natal. It is entirely distinct from the genus Anthurus.—C. **Pijper**: A prehistoric rock-sculpture from the North-Eastern Transvaal. Circular and semicircular stone markings are described, with photographs, from the Lijdenburg district, not far from stones engraved with cup-and-ring markings, which the author has previously described.—J. **Moir**: Colour and chemical constitution, part xii. The calculation of colour from the tautomeric theory. Assuming that the tautomerism C·C·OH⟶CH·C·O has the value λ 94, the tautomerism $C{\cdot}C{\cdot}NH_2 \longrightarrow CH{\cdot}C{\cdot}NH$ the value λ 98, and the tautomerism $C{\cdot}C{\cdot}CH_2 \longrightarrow CH{\cdot}C{\cdot}CH$ the value λ 103, it is shown that the molecule of a coloured substance can generally be dissected into tautomeric pieces, loaded with non-tautomeric portions which have very little effect on the colour (λ 7 to 20 only). On adding up the values of all the pieces the result agrees closely with the λ observed in the coloured substance. Yellow and orange substances have 3 or 4 tautomerisms, pink and purple substances 4 or 5, and blue and green substances 5 or 6.

SYDNEY.

Royal Society of New South Wales, August 4.—Mr. James Nangle, president, in the chair.—Dr. W. G. **Woolnough**: A geological reconnaissance of the Stirling Ranges of Western Australia. The Stirling Range is an isolated mountain block situated about sixty miles north of Albany. It is composed of interbedded quartzites and slates, devoid of fossils, and probably Proterozoic in age. While locally folded, faulted, and overthrust, the rocks are mostly horizontally stratified. The sedimentary formations are surrounded by a vast expanse of gneissic rocks, probably Archæozoic in age. After discussing the various possible explanations of the structural features observed, the author arrives at the conclusion that the sedimentary rocks were originally preserved in a long east-west fault trough, and suffered peneplanation with the rest of the "Darling Plateau" of Western Australia. Later, on the uplift of the peneplane, the old fault planes were rejuvenated, with the result that the original senkungsfeld was converted into a horst. A generalisation, which may be of far-reaching importance, is suggested, namely, that the granites of Australia lying west of a line joining Adelaide with Cloncurry are all Pre-Cambrian in age.—R. H. **Cambage** and H. **Selkirk**: Early drawings of an aboriginal ceremonial ground. The rough drawings were made by Surveyor-General Oxley in his field-book at Moreton Bay in 1824, and show the plan of a spot, as Oxley writes, "where the natives meet after a war with adverse tribes to make peace." This appears to be the first drawing showing the lay-out of a ceremonial ground of this nature in Australia, and has remained in obscurity for ninety-six years.

Books Received.

Commercial Arithmetic and Accounts. By H. H. Green and T. Franklin. With Answers. Pp. xi+337+xxxiv. (London: Macmillan and Co., Ltd.) 6*s*.

Matter and Motion. By the late Prof. J. Clerk Maxwell. Reprinted with Notes and Appendices by Sir Joseph Larmor. Pp. xv+163. (London: S.P.C.K.; New York: The Macmillan Co.) 5*s*. net.

The System of Animate Nature. The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916. By Prof. J. Arthur Thomson. Vol. i. Pp. xi+348. Vol. ii. Pp. v+349-687. (London: Williams and Norgate.) 30*s*. net.

The Natural History of South Africa. Mammals. By F. W. Fitzsimons. Vol. iii. Pp. xiii+278. Vol. iv. Pp. xix+271. (London: Longmans, Green and Co.) 12*s*. 6*d*. each vol.

Principles and Practice of Operative Dentistry. By Dr. J. S. Marshall. Fifth edition. Pp. xxix+711+xvi plates. (Philadelphia and London: J. B. Lippincott Co.) 35*s*. net.

Pure Mathematics for Engineers. By S. B. Gates. Part i. Pp. xi+191. Part ii. Pp. xi+179. (London: Hodder and Stoughton.) 4*s*. 6*d*. net each vol.

Reminiscences and Anticipations. By Prof. J. Joly. Pp. 264. (London: T. Fisher Unwin, Ltd.) 15*s*. net.

Memoirs of the Geological Survey, Scotland. The Economic Geology of the Central Coalfield of Scotland. Area iv., Paisley, Barrhead, Renfrew, and the Western Suburbs of Glasgow North and South of the Clyde. By L. W. Hinxman, E. M. Anderson, and R. G. Carruthers. Pp. iv+110+viii plates. (Edinburgh: H.M. Stationery Office; London: E. Stanford, Ltd.) 6*s*. net.

The Case against the Lloyd George Coalition. By H. Storey. Pp. v+103. (London: G. Allen and Unwin, Ltd.) 1s. net.

Historical Geography of Britain and the British Empire. (In two books.) By T. Franklin. Book ii., The Expansion and Consolidation of the British Empire, A.D. 1800 to Present Day. Pp. viii+152. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 2s. net.

Primitive Time-Reckoning. By Prof. M. P. Nilsson. Pp. xiii+384. (Lund: C. W. K. Gleerup; London: Oxford University Press.) 21s. net.

The Life of Ronald Poulton. By his Father, Edward B. Poulton. Pp. xi+410. (London: Sidgwick and Jackson, Ltd.) 16s. net.

Phenomena of Materialisation. By Baron von Schrenck Notzing. Translated by Dr. E. E. Fournier d'Albe. Pp. xii+340. (London: Kegan Paul and Co., Ltd.) 35s. net.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society. Vol. lxiii. (1918–19). (Manchester.) 12s.

The Cambridge Pocket Diary, 1920–21. Pp. xv+269. (Cambridge: At the University Press.) 3s. net.

The Elements of Plane Geometry. By Dr. C. Davison. Pp. viii+280. With Answers. (Cambridge: At the University Press.) 10s. net.

The Principles of the Phase Theory: Heterogeneous Equilibria between Salts and their Aqueous Solutions. By Dr. D. A. Clibbens. Pp. xx+383. (London: Macmillan and Co., Ltd.) 25s. net.

The Psychology of Childhood. By Dr. N. Norsworthy and Dr. M. T. Whitley. Pp. xix+375. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10s. net.

Educational Psychology. By Dr. D. Starch. Pp. xi+473. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 14s. net.

Practical Chemistry: Fundamental Facts and Applications to Modern Life. By N. H. Black and Dr. J. B. Conant. Pp. xi+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 11s. net.

A Study in Realism. By Prof. J. Laird. Pp. xii+228. (Cambridge: At the University Press.) 14s. net.

An Outline of Physics. By L. Southerns. Pp. xv+202. (London: Methuen and Co., Ltd.) 6s. 6d.

Papers Set in the Mechanical Sciences Tripos, 1912, 1913, 1914, 1915, 1919. Pp. iv+57. (Cambridge: At the University Press.) 4s. net.

Diary of Societies.

THURSDAY, OCTOBER 14.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—H. A. Hughes and P. F. Everitt: The Field of View of a Galilean Telescope.—B. K. Johnson: The Calibration of the Divided Circle of a Large Spectrometer.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—Graduates' Meeting. Messrs. Chatterton and Watson: Factors affecting Power Output.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. E. S. Reynolds: (Presidential Address), The Causes of Nervous Disease.

FRIDAY, OCTOBER 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—T. M. Ainscough: British Trade with India.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Keighley: An Evening in Lakeland.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—R. S. Fox: Elementary Physics and Chemistry in Relation to Motor Cars.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—S. Gilbert Scott: Presidential Address.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.30.

SATURDAY, OCTOBER 16.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital), at 4.

MONDAY, OCTOBER 18.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir Frederick Andrewes: Harveian Oration.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. S. G. Shattock: Demonstration of Pathological Specimens in the Museum.

TUESDAY, OCTOBER 19.

ROYAL HORTICULTURAL SOCIETY, at 3.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Sir Arthur McD. Duckham: Coal as a Future Source of Oil Fuel Supply.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. P. Chalmers Mitchell: Report on the Additions made to the Society's Menagerie during the months of June, July, August and September.—Dr. E. H. Hankin: Observations on the Flight of Flying-Fishes.—Dr. W. N. F. Woodland: Some Results of Ligaturing the Anterior Abdominal Vein in the Indian Toad (*Bufo stomaticus*).—G. Cotterell: Life-History of the Yellow Dung-Fly: a Blow-Fly Check.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. W. H. Piper: Amiens Cathedral.

WEDNESDAY, OCTOBER 20.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.

THURSDAY, OCTOBER 21.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Squad.-Ldr. R. M. Hill: A Comparison of the Flying Qualities of Single- and Twin-engined Aeroplanes.—C. Baker: Night Flying.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.45.—J. Morrow Campbell: The Origin of Primary Ore Deposits.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. A. R. Abelson: A Psychological Study of the Delinquent Child.

FRIDAY, OCTOBER 22.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Capt. H. Riall Sankey: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Martin-Duncan: Birds and Beasts from many Lands.

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