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"Index-Numbers" and Wages-Regulation.

IF we want to study the movements of prices, whether within some more or less narrowly defined group of commodities (*e.g.* foodstuffs or textiles) or over a wider range (*e.g.* all the commoner commodities consumed in the United Kingdom), the necessity is soon felt for some means of summarising the diverse fluctuations noted. This can be readily effected by taking some particular price of each commodity as a standard (usually the price in a particular year or the average over a series of years), expressing the price of that commodity at any epoch as a percentage of the standard price—thus rendering the various movements comparable—and then averaging in some way for the whole series of commodities the *index-numbers* thus obtained. The average so calculated is usually itself termed an *index-number of prices*, with some qualifying expression to show to what it relates—*e.g.* an index-number of wholesale prices, of retail prices, or whatever it may be.

When consideration is given to the planning of such an (average) index-number, a great variety of questions at once arises. For example: (1) What commodities shall be included? (2) What sorts or qualities of each commodity? (3) What prices shall be used? Wholesale prices? Retail prices? Import values? Export values? At what markets? (4) How is the standard price for each commodity to be determined? For what reference year or reference period? (5) Finally, how are the individual index-numbers to be averaged? The answers to be given on these points evidently must depend on the question that the index-number is intended to answer. Only a definite question permits of a definite answer; and two very distinct questions have dominated researches into the movements of prices: (*a*) The question of the effect of currency changes—*e.g.* the substitution of paper for gold, or the varying supplies of the precious metals. (*b*) The question of changes in the "cost of living."

Questions of the first type present their own, and numerous, difficulties; but from the point of view of practice there is one simplification, that the answer must be based on wholesale prices, quotations for which can be obtained with comparative ease. Such questions are certain to arise in a time following important new discoveries of the precious metals, as they did after the gold discoveries of 1848–49, which gave rise to two classical researches, those of William Newmarch and of Jevons.

Newmarch[1] used twenty-two quotations, no fewer than four of which were for cotton. 1845–50 was taken as the reference period. At first no summary was attempted; later the index-numbers for the individual commodities were simply added together instead of being averaged, so that the base-figure was 2200 instead of 100. Virtually, however, the index-number was the simple arithmetic mean of its components. This index-number has been given monthly in the *Economist* almost without a break since 1869, and remained on precisely the same basis until 1911. The inconvenience of the old basis had by this time become very marked—such vital commodities as foreign wheat, steel, petroleum, and rubber were not included—and the whole basis was revised. The number of quotations was raised from twenty-two to forty-four, and the base-period was altered from 1845–50 to 1901–5. When the simple arithmetic mean is used for the average the base-period is important, as it determines a virtual system of weighting.

The work of Jevons[2] (1863–65) is mainly of importance from his use of the geometric mean as the form of average. Without entering into the reasons that he assigned, some of which are obscure, one reason is clear and important. If the geometric mean be used, the ratio of the index-number for any year B to year A is the

[1] Cf. vols. v. and vi. of "The History of Prices," by Tooke and Newmarch; the Mercantile Reports by Newmarch in the Journal of the Royal Statistical Society, vols. xxii., xxiii., and xxiv.; and the volumes of the *Economist* from 1864. The summary figure appears to have been first given in 1869.

[2] Reprinted in "Investigations in Currency and Finance" (Macmillan, 1864).

same whatever year be used as base, and this is not the case if the arithmetic mean be used. Jevons's calculations were not maintained, but his work on this point of method has been fruitful.

Sauerbeck,[3] having regard to the unsatisfactory character of the old *Economist* number, constructed in 1886 a fresh index, using forty-five quotations. His base-period was the eleven years 1867–77, and he again used the simple arithmetic average for his mean. The calculation of the index-number was maintained, and it has now become the index-number of the *Statist*. In some ways this number also is no longer entirely satisfactory; foreign meat, for example, is not included, nor rubber.

The Board of Trade[4] in 1903 constructed an official index-number of wholesale prices in which a weighted arithmetic mean of the individual index-numbers was used, weights being given by the estimated values consumed. It was not a satisfactory number. The correct method of weighting does not seem to have been realised, and the weights actually used were based on a period different both from the reference year first employed (1871) and from that used later (1900), with the result that two widely divergent series of figures have been given. Very rightly the Board has decided that the old number should now be entirely dropped and a fresh index constructed on a new basis. This basis was fully described in a paper by Mr. A. W. Flux,[5] of the Board of Trade, read before the Royal Statistical Society for discussion in January last. So many as 150 quotations are used for the new number, and the geometric mean is employed, thus freeing the results from any influence of choice of reference period, and obtaining a completely consistent series of averages. No actual weights are used, but, as in the case of the *Economist* and the *Statist* index-numbers, there will be an approximate weighting by assigning more quotations to the more important commodities. It must be noted also that this number is really devised to answer a question different from that faced by Newmarch or Jevons—the effect, not of currency on prices, but of prices on currency. In the case of dutiable commodities the duty will therefore be included in the price; prices will not be quoted duty-free as in the case of the other wholesale numbers. The number, the first figures for which have been published in the *Board of Trade Journal*, represents a great advance.

All the above index-numbers are essentially index-numbers of wholesale prices, and deal preponderantly, though not wholly, with raw materials. Clearly this is not what is required for an index-number of "cost of living." But what do we mean by that very elastic phrase? As soon as we endeavour really to analyse the term, it becomes extraordinarily difficult to say. The clearest definition is "the cost of purchasing year by year the same schedule of commodities and services." It is nearly a century since Joseph Lowe[6] attempted calculations on this basis for the change in "cost of living" between 1792, 1813, and 1823 for a country labourer, a town mechanic, and a middle-class family, using estimated budgets of normal expenditure as his foundation. He also suggested the voluntary regulation of wages and salaries on such a basis.

It cannot be said that we have advanced much beyond this work of a century ago so far as regards method. The Board of Trade, soon after the beginning of the war, began the publication of an index-number of retail prices in the *Labour Gazette*, afterwards maintained by the Ministry of Labour. At first it was termed an index-number of "cost of living," but, very judiciously, that phrase was afterwards dropped, and it is now referred to only as a measure of changes in retail prices. It is to be regretted that not only members of the public, but also members of the Government themselves, still, nevertheless, continue to refer to it as an index of the "cost of living." The process of calculation was fully described in the *Labour Gazette* for March, 1920. A fixed schedule of foodstuffs was taken, based on the pre-war consumption of a working-class family, and the total cost of this schedule at the prices of the day compared with the prices of July, 1914, gives an index-number for food; index-numbers for working-class rents, clothing, fuel and light, and miscellanea (ironmongery, brushware, and pottery; soap and soda; tobacco and cigarettes; fares and newspapers) are determined by other inquiries, and these several group-indexes are combined into a general average on the basis of weights determined from pre-war expenditure.

The number is thus based entirely on the conception of purchasing a fixed schedule—the maintenance of a fixed mode of life. But when prices

[3] Journ. Stat. Soc., vol. xlix., 1886; subsidiary papers and annual reviews since.

[4] Report No. 321, 1903, and later *Labour Gazette* or "Annual Abstract of Labour Statistics."

[5] Journ. Stat. Soc., March, 1921. The paper has also been separately printed.

[6] "The Present State of England" (London, 1822, and second edition, 1823).

change, people do not maintain their previous mode of life in absolute fixity, and in war-time they cannot do so. What, then, is to be done? The Committee[7] appointed in March, 1918, to report on "the actual increase since June, 1914, in the cost of living to the working classes," under the chairmanship of Lord Sumner, based its number on the actual *expenditure on living*—*i.e.* if a working-class family of definite size spent £x in the earlier year, and £y in the later year, the index-number of "cost of living" was taken as y/x. However interesting such a figure[8] may be—and it obviously has its interest—it is certainly not deserving of the title "an index-number of cost of living." To its use for regulating wages Labour leaders made the obvious objection: "If we can buy next to no food, you will say that we need have next to no wages." Had the Committee suggested (and the suggestion arises naturally out of its report) that, in the case of food, the Calorie-value of the dietary should be kept constant, this objection would have been obviated. If an index-number is to deserve the name of an index-number of cost of living at all, there must be fixity of a standard of some kind.

But the virulence of the discussion that has centred round the Ministry of Labour number is largely due to this fact, that it has been used as the basis of wages-regulation. Need a number for regulating wages (if they ought to be so regulated, which is itself a very debatable question) be a number for "cost of living"? For example, Customs and Excise duties certainly contribute to cost of living; but they are meant to be paid by those who choose to consume the dutiable commodities. Ought they, then, to be included, as duties are included in the Ministry of Labour number, in an index for regulating wages, thus merely shifting payment to the employer? Again, ought luxuries to be included? Neither tobacco nor newspapers can be called necessities. They are rightly included when it is a question of constructing an index-number of "cost of living." Ought they to be included in a number for wages-regulation, as in the Ministry of Labour number? These, and the like, are certainly questions that ought to be discussed, and if it is realised that the index-number is intended to serve the purpose of regulating wages, and not of indicating some vaguely conceived "cost of living," it may be possible to arrive at definite and agreed answers. The revision of the Ministry of Labour number will certainly have to be considered in the near future. Any revision should be carried out with a definite conception of the real end in view. If the Ministry of Labour would extend its views so far as to have some regard to working members of the community other than those who work with their hands for a weekly wage, it might consider the formation of a number more nearly related to the expenditure of the middle classes. No index-number of prices exists which forms any adequate basis for the regulation of salaries. Both the Ministry of Labour number and various wholesale numbers have, we believe, been used, but they are not satisfactory.

It is, in fact, time that the entire question of regulating wages and salaries in accordance with price movements, its justification, the formation of index-numbers for different classes of wage-earners (skilled and unskilled labour do not have the same budget; miners who get coal free and houses free ought not to have their wages affected by movements in rents and coal prices) and of salary-earners, and the relation that should subsist between a given movement in the index and the movement in the wage or salary should be fundamentally reconsidered.

[7] Cd. 8980, 1918. Cf. also Cd. 76, 1919, on "Cost of Living of Rural Workers," and the paper by Dr. A. L. Bowley on the measurement of changes in the cost of living, Journ. Stat. Soc., vol. lxxxii., 1919.

[8] Indexes of "expenditure on food" as against food prices were given for some time during the war in the *Labour Gazette*.

Psychology and Psychopathology.

(1) *Instinct and the Unconscious: A Contribution to a Biological Theory of the Psycho-Neuroses.* By Dr. W. H. R. Rivers. (The Cambridge Medical Series.) Pp. viii+252. (Cambridge: At the University Press, 1920.) 16*s.* net.

(2) *Psychoanalysis: Its History, Theory, and Practice.* By André Tridon. Pp. xi+272. (London: Kegan Paul, Trench, Trubner, and Co., Ltd., 1919.) 10*s.* 6*d.* net.

(1) THE investigations and theories of Freud have exerted a profound effect upon the development of psychology. This can be seen not only in the rapidly increasing body of teaching put forth by Freud and his orthodox followers, but still more in the mass of writings now appearing which are based largely on certain of Freud's fundamental doctrines, although they are developed along lines diverging widely from those accepted by the psychoanalyst.

In this latter group Dr. Rivers's work merits special attention, because, unlike so many of that prolific harvest of psychological and psychopatho-

logical books of which the war has sown the seed, it is not a mere *réchauffé* of other people's views, but the fruit of independent and efficient thought, and a solid attempt to advance scientific knowledge. The main portion of the book, comprising 158 pages, consists of a series of lectures delivered at Cambridge. The remaining pages contain reprints of papers written for various journals, which are related only indirectly to the consistent plan of development carried out in the lectures.

The author accepts in the main Freud's conception of the unconscious, and the "mechanisms" of conflict, repression, and so forth whereby Freud seeks to explain the processes occurring in consciousness, although considerable modifications in nomenclature and definition are introduced. He accepts also the view that the activities of consciousness are to be regarded as the resultant of various instinctive forces, but he develops this conception along lines which are partly akin to those worked out by McDougall, and partly the result of an independent mode of approach. The subject is regarded from a biological point of view, and the essential feature of the author's treatment is an attempt to bring the processes of consciousness, both in the normal and in the psychoneuroses, into relation with processes occurring at physiological levels, all being incorporated in a scheme of biological development. Thus suggestion, conflict, repression, and even such phenomena as sleep and hypnosis, are analysed into modes of reaction comparable with those discovered by Head and his fellow-workers to exist in physiological reflexes and in the mechanism of sensation. This view is extremely interesting and suggestive, though it may be doubted whether the relation is not one of analogy rather than of the identity which Dr. Rivers seems to postulate.

The same line of thought is carried on into the author's treatment of the psychoneuroses. Here, again, he accepts the main Freudian position that the psychoneuroses are due to conflicts occurring between the great instinctive forces of the mind, and that they are to be regarded biologically as attempts to find some solution of these conflicts. With regard to the nature of the instinctive forces concerned, however, he brings forward hypotheses which are open to considerable criticism. He suggests, for example, that hysteria is essentially dependent upon the activity of the danger-instincts, and implies that the type of hysteria met with in the war is the fundamental form of that disorder. This generalisation seems to be subject to the same accusation of narrowness and one-sidedness as has been levelled at the corresponding view of Freud that hysteria is essentially dependent upon the sex instincts, and it can scarcely have behind it the weight of clinical experience upon which the latter view was founded. It is to be remarked, moreover, that Dr. Rivers does not discuss the recent work of the Freud school on narcissism and the attempts which have been made to explain the war type of hysteria by means of this conception.

Another noteworthy omission is the absence of any reference to Trotter's views on herd-instinct, which surely ought at least to be considered in a work dealing with the fundamental reactions of the mind.

The papers forming the appendix are all of considerable interest, although, as has been said, they have only an indirect bearing on the main argument of the lectures. The book as a whole is, without doubt, one of the most important recent contributions to psychological literature.

(2) Dr. Tridon's book is of an altogether different type. It makes no claim to put forward any original line of thought, and its aim is best expressed in the author's own words as an attempt "to sum up in a concise form the views of the greatest American and foreign analysts." It includes a description not only of the doctrines of the orthodox Freud school, but also of those of Jung and Adler, who, although they originally worked with the Freud school, have now diverged from it to a very wide extent. To carry out such an aim within the limits of a small book is clearly a very difficult task, and Dr. Tridon will probably fail to satisfy the exponents of any of these divergent schools. He has, however, succeeded in producing a very readable and interesting book.

French Chemists and the War.

La Chimie et la Guerre, Science et Avenir. By Prof. Charles Moureu. ("Les Leçons de la Guerre.") Pp. iii+384. (Paris: Masson et Cie, 1920.) 10 francs net.

THE well-known publishing house of Masson et Cie, Paris, is issuing a series of volumes under the general title of "Les Leçons de la Guerre," with special reference to the experiences, circumstances, and prospects of France. The books which have already appeared deal with the military, naval, and aeronautical lessons of the war; with the effect of the war, immediate and prospective, on French industry; with alimentation and revictualling; and lastly with the influence of science, and particularly of chemistry, on the war, and, reciprocally,

with the influence of the war on the present condition and future development of that science. The volume under review is the work of Prof. C. Moureu, member of the Institute of France, professor of the Collège de France, president of the Chemical Society of France and of the International Union of Chemistry. No one is better fitted to expound the mutual relations of chemistry and war than Prof. Moureu, for no one during its course took a more active part in placing all the resources of that science at the disposal of his country. As is now well recognised, all the Allies vied with Germany in enlisting the services of their chemists in the prosecution of the war, and their united energy, resourcefulness, and skill eventually crushed their adversary. As the war was conducted, military valour, tenacity, and intelligent direction would not alone have decided the issue. Germany had imported a new element into the struggle which gave her an enormous initial advantage. The services of her great chemical manufacturing establishments had been deliberately and sedulously linked up for years previously with the war which was being prepared for in such a manner that, on its outbreak, all their appointments and machinery could at once be made available for its ruthless prosecution by every means which the diabolical ingenuity of their chemists could suggest.

April 22, 1915, which first saw the yellowish-green suffocating cloud of chlorine slowly wafted from the German trenches between Bixschoote and Langemark, is a black-letter day in the history of warfare. The infamous action of the Germans, done in cynical disregard of all international effort to mitigate the horrors of war, shocked the conscience of the civilised world. Whatever trace of knightly prowess or chivalry was left in modern war was thereby destroyed. To employ poisons against your enemy was the work of savages. What, it may be asked, was the ethical value of the boasted *Kultur* of a nation which could not only initiate, but also strive to develop and to intensify the evil of such agencies by all the means that its scientific knowledge and skill could suggest? The following table, taken from Prof. Moureu's book, giving a list of the chemical poisons, solid, liquid, and gaseous, which the Germans flung at their adversaries in the course of the war, requires no comment—at least to the organic chemist at all familiar with the noxious characters of such products. Their physiological action became only too well known by bitter experience.

Date when first used on the field of battle.	Name of substance.	Chemical formula.	Physiological action.
1915			
April	Chlorine (gas)	Cl_2	Suffocating
June	Bromine (liquid)	Br_2	Suffocating
June	Benzylbromide (liquid)	$C_6H_5—CH_2Br$	Lachrymatory
July	Bromoacetone (liquid)	$CH_3—CO—CH_2Br$	Suffocating, lachrymatory
Aug.	Methyl chlorosulphonate (liquid)	$SO_2\begin{matrix}Cl\\OCH_3\end{matrix}$	Suffocating
Aug.	Chloromethyl chloroformate (liquid)	$Cl—COOCH_2Cl$	Suffocating
Aug.	Bromomethyl ethylacetone (liquid)	$CH_3—CO—CHBr—CH_3$	Suffocating, lachrymatory
1916			
July	Trichloromethyl chloroformate (liquid)	$Cl—COOCCl_3$	Suffocating
Dec.	Phosgene (gas)	$COCl_2$	Suffocating
1917			
May	Chloropicrin (liquid)	CCl_3NO_2	Suffocating, lachrymatory
July	"Mustard gas" (ypérite) (liquid)	$S\begin{matrix}CH_2.CH_2Cl\\CH_2.CH_2Cl\end{matrix}$	Suffocating, lachrymatory, vesicant
Sept.	Diphenylchloroarsine (solid)	$(C_6H_5)_2AsCl$	Suffocating, sternutatory
	Phenyldichloroarsine (liquid)	$C_6H_5AsCl_2$	
Sept.	Phenylcarbylamine chloride (liquid)	$C_6H_5N:C:Cl_2$	Nauseous and toxic
1918			
April	Ethylarsine dichloride (liquid)	$C_2H_5AsCl_2$	Toxic, sternutatory
April	Ethylarsine dibromide (liquid)	$C_2H_5AsBr_2$	Toxic, sternutatory
June	Diphenylarsine cyanide (solid)	$(C_6H_5)_2AsCN$	Sternutatory
Sept.	N-Ethylcarbazol (solid)	$C_6H_4—C_6H_4\\NC_2H_5$	Sternutatory

Lord Kitchener at first refused to sanction reprisals of a like nature. But the French were prompt to meet the new danger. They realised that such reprisals were imperatively necessary in self-defence. Although, as was the case with all the Allies, France was totally unprepared for such savagery, before the end of April, 1915, she had organised means of protection and of counter-aggression in which the author of the book under review took a leading part.

Considerations of space preclude any detailed account of the way in which the dastardly action of the Germans was met and finally mastered. By the united efforts of the Allies, working in concert, the Germans were eventually taught a lesson which made their leaders bitterly regret that they had ever resorted to "poison gas" as an offensive

agent. It brought its own Nemesis by ultimately destroying the German *moral*.

The story of the organisation of the chemical and medical services of the war, as regards France, is the main theme of Prof. Moureu's book. He explains in detail how the whole procedure was gradually systematised. Nothing is more remarkable than the rapidity with which the chemical and medical strength of the nation was enlisted and co-ordinated. France is pre-eminently a logical nation, and her mental habitudes served her admirably, and, indeed, saved her in the crisis which had well-nigh overwhelmed her.

As regards her chemists, practically every name of note in the French chemical world is to be found in the lists furnished by Prof. Moureu. From first to last 268 French chemists were employed in the chemical services of the war. Thirteen of the laboratories in Paris were wholly concerned with the study of counter-aggressives alone. But the work of reprisals extended far beyond counter-aggressives. The services of the chemists were concerned with metallurgy, the production of alloys, the manufacture of explosives, aeronautics, camouflage, supply, sanitation, alimentation, medicaments, photographic chemicals, radio-active substances, and a host of minor matters, such as the recovery of solvents, optical glass, potash, platinum, etc. France, like this country, had gradually allowed Germany to obtain control of the manufacture of many articles as essential in war as in peace. Their production by the Allies had to be suddenly improvised. In some cases little or nothing was known concerning the details of their manufacture, and study and experiment were needed before their preparation on the large scale could be attempted.

But when the German onslaught had spent itself at the Marne France gained a breathing time, and she rapidly made up her leeway. Her success will permanently benefit her industry. She has consolidated the manufacture of certain articles for which, like us, she was formerly wholly dependent on Germany, and is now in a position to export them—a consummation which she owes, in great measure, to the patriotism and self-sacrifice of her chemists.

Prof. Moureu has conferred a benefit on his country by the compilation of this admirable work. The lessons it conveys are of profound importance to the national well-being. So far we have had nothing exactly like it in this country. But England has a no less thrilling story to tell. And it should be told quickly, lest we forget. Prof. Moureu's book affords an example of how to tell it. T. E. THORPE.

Sport and Administration in Central Africa.

The Backbone of Africa: A Record of Travel during the Great War, with Some Suggestions for Administrative Reform. By Sir Alfred Sharpe. Pp. 232. (London: H. F. and G. Witherby, 1921.) 16*s*. net.

SIR ALFRED SHARPE first entered East Africa for the purpose of big-game shooting in about 1886. He was on long leave just then from a magistracy in Fiji. In 1887 he joined Lugard at the north end of Lake Nyasa, Lugard being engaged in a desperate fight with the Arab slave-traders established to the north-west of the Nyasa lake. In 1888 Sharpe was wounded in this bitter struggle, and in 1889 he returned and became a British Vice-Consul in that region. In 1891 he was made a Consul under the present writer's Commissionership, and served with him in what was then called "British Central Africa" until Johnston's transference to Tunis in 1897. Afterwards Sharpe became Governor of Nyasaland, and remained in that position until his retirement after the Coronation of King George in 1911. He was given a prominent part in the Coronation procession.

In 1912, unable to abate his interest in Africa, Sir Alfred Sharpe returned there as a private traveller and an adviser of highly placed trading companies. In this capacity, and still more as just one athirst for the solving of African secrets in fauna, flora, geography, and ethnology, he penetrated and repenetrated the eastern half of Africa from the southernmost parts of Portuguese East Africa to the Sudan and Egypt in the years between 1912 and 1917. He had hoped to serve strenuously in our wars with Germany during much of that period, but just because he so singularly knew East Africa, South-east Africa, Uganda, and Tanganyika, any British commission was withheld from him by Lord Kitchener; and his war service, for which he was recently rewarded, was with the Belgian armies. Since 1918 he has been making a special study of Liberia and contiguous regions in West Africa.

The book here reviewed is of great interest because it is so truthful. Sir Alfred Sharpe has no object to serve other than that of telling the truth about Africa, whether it suits one's theories or not. Whilst the material of the present work was being put together he was already lecturing to the Royal Geographical Society on Liberia, in the most forested part of West Africa.

For the naturalist, the best parts of the book under review are the statements about elephants (Sir Alfred, though never an offender against big-

game regulations, has discriminatingly shot elephants in Central, South-east, North Central, and West Africa), about a sub-fossil relic of the small forest elephants of West Central Africa, the tsetse-flies, the giant gorilla in the Lake Kivu region, and the vast herds of cattle to be found in Ruanda, a region which since the Great War has been handed over to Belgium to administer. The author thinks that the cattle in Ruanda—of an exaggerated straight-backed Indian type, with immense horns—must amount to two and a half millions. They die away (I might add) when brought down from the upland region to the countries of the tsetse-fly at lower levels. Unfortunately, the Watusi of Ruanda, once the "great" people of all that region and under other names of the lands between Tanganyika, Victoria and Albert Nyanzas, have become deplorably idle and wanton, and circumstances will oblige them to pull themselves together and reform.

H. H. JOHNSTON.

Our Bookshelf.

The Modern Teacher: Essays on Educational Aims and Methods. Edited by A. Watson Bain. With an Introduction by Sir W. Henry Hadow. Pp. xv+272. (London: Methuen and Co., Ltd., 1921.) 10*s.* 6*d.* net.

THIS attractive volume contains ten essays, by writers of undoubted authority, on the chief subjects of school curricula, including civics, but excluding art and music. As each author has written independently of the others, there is a refreshing diversity in the modes of treatment. These vary from what is almost an apology by Mr. George Smith for the teaching of classics to Mr. A. W. Lucy's confident assurance, which allows him to plunge straight into practical details, in the case of mathematics. Even in defining the chief aims of education the essayists give conflicting opinions—which is all to the good, for it is when we think alike that we have ceased to think at all. In the section on science, for example, Mr. F. W. Sanderson reaffirms that it is the duty of education to "teach the average man the glory of his daily work and trade." The conspicuous success which has attended Mr. Sanderson's work at Oundle School makes his contribution to the volume a welcome one; the more so since, besides stating his ideals, he has indicated the lines along which they may be approached in practice.

The teacher who reads this book will not fail to find useful suggestions scattered about the more familiar paths of his knowledge; but probably its chief value for him will lie in the restoration of a true perspective, an appreciation of the complementary nature of the various branches of learning.

The Yearbook of the Universities of the Empire. 1921. Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xiv+571. (London: G. Bell and Sons, Ltd., 1921.) 15*s.* net.

WE are glad to be able to extend a welcome to the fifth edition of this useful volume. The plan adopted in the fourth edition of arranging the universities in groups—England, Wales, Scotland, Ireland, Canada, Australia, and so on—has been adhered to, and a brief introductory note precedes each group. A feature of the new edition is the numerous appendices, into which a vast amount of useful information has been incorporated. Short accounts are given of the institutes of accountants, architects, auctioneers, engineers, pharmaceutical chemists, and chartered secretaries, and of numerous other societies such as the Institute of Chemistry, the various colleges of physicians and surgeons of the United Kingdom, together with the regulations as to admission to these bodies. Particulars are also included of the matriculation examinations by joint boards and of inter-university scholarships, fellowships, etc. In Appendix XVIII. an account is given of the conditions under which undergraduates and research students are admitted to foreign universities. The facilities for foreign students in most of the principal universities in America and in Europe, with the exception of the German and Austrian universities, are included in this section. The records are necessarily brief, but the information brought together is not readily available in any other single volume, and it makes the book invaluable as a work of reference.

Laboratory Manual of Organic Chemistry. By Dr. H. L. Fisher. Pp. x+331. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 12*s.* 6*d.* net.

FULL experimental details and numerous practical hints which should be found very helpful form an unusual feature of manuals of practical organic chemistry. The theory of the preparations is not given, even in outline, but references to other textbooks are provided. This method does not seem likely to be so successful as that in which a brief but clear account of the reaction is given before the experiment is described. The section on organic analysis, which takes up 92 pages, is out of proportion, and far too detailed for a book of this kind.

Annual Reports on the Progress of Chemistry for 1920. Issued by the Chemical Society. Vol. xvii. Pp. x+264. (London: Gurney and Jackson, 1921.) 7*s* 6*d.* net.

THE annual reports of the Chemical Society are valued as accurate and concise summaries of the main lines of advance in all branches of the pure science made during the year. The present volume maintains the high standard associated with previous issues.

Letters to the Editor.

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The Constitution of Nickel.

My latest experiments have enabled me to obtain the mass spectrum of the element nickel by using the vapour of nickel carbonyl mixed with carbon dioxide. The ordinary discharge tube was employed to produce the positive rays, and difficulties of maintaining a steady discharge were overcome to some degree by the use of comparatively high pressure and a heavy current. The rays were analysed in the usual way by means of the mass spectrograph.

The spectrum consists of two lines, the stronger at 58 and the weaker at 60. They are most conveniently placed between the mercury groups of the third and fourth order, with which they can be compared with an accuracy of 1/10th per cent. The results were also checked by comparison with the CO_2 line 44, and appear to be integral within the above error. Nickel therefore consists of at least two isotopes. The intensities of the lines are about in the ratio 2 : 1, and this agrees with the accepted atomic weight 58·68. F. W. ASTON.

Cavendish Laboratory, Cambridge, June 10.

A Novel Magneto-Optical Effect.

EARLY in April last, while my son, Malcolm Thomson, was operating, in a building of the River Works plant of the General Electric Co., a resistance welder for closing the seams of steel Langmuir mercury vacuum pumps, in which work the current is applied and cut off at about one-half second intervals, there was noticed by one of the working force, Mr. Davis, who happened to be favourably located, a peculiar intermittent illumination of the space near the welder as the current went on and off. My son at once placed himself in a similar position and saw the novel effect, and noted a number of conditions accompanying it, perhaps the most important being that a single-turn loop from the welding transformer to the work and back was carrying about 7000 amperes, and that the luminous effect was spread in the space in which would be located the magnetic field from this loop; that the sunlight was entering the building through high windows and shining across the space in which the field was produced at intervals; that the effect was most conspicuous when one looked towards the shadows and across the sunbeams, and also across the magnetic field.

This would be expressed by saying that the best effect was observed when the line of vision was downward at an angle intersecting the entering sunbeams, and into the shadows under the beam furnished fortunately by a partition a few feet high, over which the sunlight came. The magnetic field, neglecting the curvature of the lines, was, generally speaking, at right angles to the line of sight and to the direction of the sunlight. My son also noticed that the effect of increased luminosity was coincident with the putting on of the current, and disappeared at once on cutting off the field. It was thus clear that it depended on the establishment of the magnetic field. He reported these facts to me, and they were confirmed by me. Other observers were soon enlisted, and on several favourable sunny days all the above observations were confirmed by them. Further, my son had not been able to see any effect when looking across the sunbeam from the opposite side. This means that, with the sunbeams streaming in from the south, the effect was observed looking southward and downward, the windows admitting the light being to the south. Looking from the south across the beam gave no result, though it was not possible to look directly across the beam on a slant upward into any dark shadows and at the same time have the line of vision cross the magnetic field.

It is interesting to note at this point that the luminosity filled the whole space, and extended as far away as four feet or more from the magnetic loop, and that it was not especially noted as more intense near the loop than at a distance therefrom of, say, two feet or more.

Mr. Malcolm Thomson had further observed that by cutting out the loop from the secondary terminals (clamps) of the welding transformer, and simply joining those terminals by an iron bar, as is done in resistance welding, the luminous effect in the neighbourhood of the transformer was still visible, but was much more feeble than when the heavy loop was used. It occurred to me to examine the light by a large Nicol's prism. It was found that there was a distinct polarisation of the light from the space. This means that when the magnetic field was on the sunlight was scattered in the direction of the observer from the space occupied by the sunlight beam and the magnetic field, and that such scattered or deflected light was polarised.

It occurred to me, as a possible factor in the case, that as the building was used in part to carry on arc welding by iron arcs there might be suspended in the air of the building iron particles or finely divided oxides or compounds of iron which in some way were oriented by the magnetic field, resulting in the scattered light noted. This was confirmed in part by making the test observations when the large doors of the building had been open for some hours. The effect was present, though difficult to detect. This led to the suggestion to bring an iron arc into operation near the space in which the luminous effect had been seen. This was done, and with an enhancement of the effect.

At this stage the further observations were carried on in the Thomson Laboratory at Lynn, Mass., with the aid of the laboratory staff (A. L. Ellis, H. L. Watson, Dr. Hollnagel, and others).

Two sets of test apparatus were prepared at my suggestion. One large welding transformer was mounted in a special room, into which the sunbeams could be received in the afternoon as the windows faced south by west. The secondary terminals were joined by a large loop of heavy copper cable (about 12 sq. cm. section) of a loop diameter of 0·6 m. The loop consisted of two turns. The plane of the loop was vertical and was nearly north and south, or in a plane parallel to the direction of the entering sunbeams, so that the magnetic field would be in the main horizontal and transverse to the light of the sun entering downward as before. An iron arc was arranged to be operated so that the smoke from it would rise from below and enter the field of the loop, and by changing the relative position of the arc the smoke column, widening as it rose, could be made to bathe the turns of the coil, cross its axis, or, at a distance away, merely enter the field. As the experiments thus far had always involved connection to the shop plant, with 60-cycle alternating current, a check apparatus was set up, consisting of a storage battery (of a type such as is used in automobile

starting) arranged on a stand. In circuit with it, and under control of a switch, was a coil of about 0·2 m. diameter, and giving a field due to about 2500 ampere turns when the switch was closed. This second apparatus could be moved about, and was entirely independent of supply circuits or static disturbances which might be present in them.

The first tests were made with the transformer loop (representing a field of 20,000 ampere turns), and were very striking. The rising smoke from the small iron arc, only moderately visible in the sunbeam, became decidedly luminous when the field was put on. Each closure of the current switch to the primary of the transformer was instantly followed by the brilliant smoke effect, and the effect instantly disappeared on the opening. A black background had been provided in front of which the smoke rose. After the arc had been running a few minutes only it was seen that the air of the room was carrying sufficient of the smoke particles to give the effect anywhere in the space covered by the magnetic field and the sunbeams, even a number of feet away from the coil. In this case the appearance was as if in the air there were diffused some substance or material which became visible only in the combined sunlight and magnetic field. That in this case the luminous effect is not greater near the coil loop than some feet away indicates that orientation, or whatever causes the effect, is complete even in a rather weak field. Thorough ventilation of the room by opening windows caused the effect to fade out gradually by removal of the active particles.

The experiments with direct-current coil and battery conclusively showed that the effect was present with it as with alternating current, and incidentally established the fact that the effect on the particles is independent of the direction of magnetisation. It is doubtful if high-frequency tests would allow us to discover whether the establishment of the effect requires time. Probably not. Observations made through the axis of the loop of two turns show a minimum of effect, from which it may be inferred that it is not present if the viewing is exactly along the field-line direction.

Polarisation.—Having obtained, as described in the foregoing, a controllable and relatively brilliant source of the luminosity, tests with the Nicol's prism were resumed. It was soon noted that the polarisation was decided as controlled by the magnetic field. Moreover, the very curious fact was discovered by me, that the fumes from the iron arc were composite so far as analysis by the polarising prism was concerned. The bluish-coloured smoke arising gave but little effect, but there was with it a yellowish-grey fume, which was highly luminous in one position of viewing by the prism, and invisible when the prism was at right angles to that position. This indicates complete polarisation when the field is on for the light diffused from the particles in the yellowish-grey fumes. This is an extraordinary effect for which no explanation suggests itself, for the field lines are not straight, but wrap themselves around the coil or loop in curved directions, and the effect is apparently complete even with the fumes rising in the space where the lines are strongly curved.

It remains to use a vertical beam of light and make tests from opposite directions across the field, also to use artificial light instead of sunlight. It would seem possible to design a small demonstration apparatus consisting of a coil to be put on a battery or lighting circuit, A.C. or D.C., a small iron arc between two wires, a box with darkened interior to be filled with fumes, having two sides of glass, one for the admission of the light beam and the other a window at right angles for observation. Two coils placed outside the box space and opposite each other, or capable of application in different relations, would have advantages. Eye shields to cut out extraneous light and a tortuous chimney conveying the smoke, but cutting off the light from the iron arc, are desirable additions to the equipment, as also an analyser as part of the apparatus for the polarisation effect.

The Microscope.—Attempts have been made to catch the particles in the smoke from the arc upon a glass slide for microscopic examination as to their form under high powers. That they are exceedingly fine is evident from their remaining in suspension so long in the air and diffusing themselves rapidly through the air. That an exceedingly small amount of material suffices for making the whole air of a large room capable of showing the effect is evident also. The sunbeam may enter the room, and its course is not disclosed by them unless the magnetic field exists. It seems natural to suppose that the particles consist of some form of iron or iron oxide, but without proof this cannot be fully decided. Other particles might exist, giving such an effect, but it must be confessed this does not seem probable. Other fumes and smoke from arcs so far have given no results. The smoke from a nickel arc does not give the effect. Whether a cobalt arc will yield fumes behaving like iron smoke is not yet known.

The fumes and smoke of an iron arc were caught on a clean microscope slide until a patch of sediment of a slightly yellowish-brown tint, but very pale, was deposited. Under moderate powers very little of any definiteness is shown, but under the high power of an oil-immersion lens of about 1½ mm. focal length there is disclosed a curious structure of particles seemingly between 0·0002 and 0·0001 mm. diameter, which particles are frequently strung together, 4, 5, 6, or more, in a line, giving the effect of a short piece of chain made of small roundish particles, slightly spaced apart, or of a short section of a string of beads (round beads) not touching one another. Many of these structures appear to be straight, and some are curved. Evidently in a magnetic field these chains of particles, presumably of oxide of iron and magnetic, would line up and reflect or diffuse light of the sun striking them. If the direction of vision was such as to favour polarisation of the rays in a direction nearly at right angles to the incidence of the solar beam the polariscope effect would be accounted for measurably. Apart from polarisation, the lining up of the chains would also account for the extra *visibility* of the smoke under the conditions of the experiment.

It would seem from the foregoing that a considerable length of column of smoke from the iron arc, subjected transversely to a magnetic field, might be expected to act as a means of obtaining polarised light in the direction of the beam itself. This assumes that there will be a considerable scattering of light polarised as above described in a direction sidewise, leaving the light which passes through polarised in a plane at right angles. The apparatus might be compared in its action to a Nicol's prism, transmitting rays in one plane and throwing out laterally those in the other. This suggestion will be tested as soon as proper arrangements can be made.

The polarised light which is sent out from the smoke particles in a direction transverse to the sunlight beams, when the magnetic field is put on, is in the same plane as that reflected from a sheet of glass at the polarising angle receiving the same beam. This fact is in accordance with what might be ex-

pected if the short sections of chain or beaded particles were oriented or lined up by the magnetic field; the transverse waves of light vibrating in a plane intersecting the length of the chains would not be deflected on account of the extremely small diameter of the particles composing them, but waves vibrating in the plane of the length of the chains would be reflected to the side, and this would account for their plane of polarisation being what it is. Such waves would behave as if reflected from short rods in line with the plane of vibration, while the extremely small diameter of the rods would not sufficiently intercept the light vibrating in a plane transverse to their length.

The continuation of the investigation with artificial light and other varied conditions is anticipated.

ELIHU THOMSON.

Thomson Laboratory of General Electric Co.,
Lynn, Mass., May 23.

Geometrical Isomerism in Monomolecular Films.

IN the course of investigations on these films by a method differing only in details from that described by Langmuir (Journ. Amer. Chem. Soc., 1917, p. 1868) I have found striking differences between the properties of films formed from the "cis" and "trans" forms of some fatty acids containing an ethylenic linkage, which indicate that of the two pairs of acids, oleic and elaidic, erucic and brassidic, oleic and erucic are the "cis" forms and elaidic and brassidic the "trans." The results appear to be consistent with Langmuir's conception of the structure of the films, and this stereochemical configuration is that usually regarded as correct from chemical considerations.

According to the theory, the films are one molecule in thickness. With saturated acids, such as palmitic, the molecules are attracted to the water by the

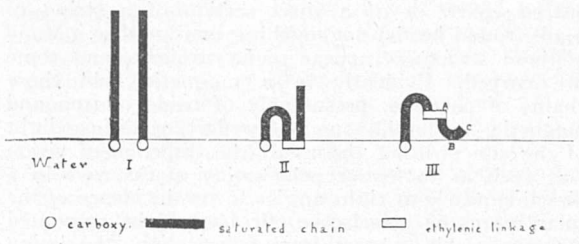

FIG. 1.

carboxyl groups, and are arranged as in Fig. 1, I. Unsaturated acids are also attracted by their ethylenic linkages, and when, as in the acids mentioned, these are approximately in the middle of the chains, the molecules in the film will take up the position in Fig. 1, II. or III. The attraction of the double bond for water is less powerful than that of the carboxyl, and when a lateral compression is applied to the film the area per molecule will diminish by some or all of the molecules straightening out to the position I.

Fig. 1 shows that a difference is to be expected between the "cis" and "trans" isomers. The double bond in the "cis" form can approach as closely as desired to the water, but in the "trans" form *the saturated portion of the chain ABC must be forced in among the water molecules.* Although it is known from stereochemical considerations that a hydrocarbon chain is flexible, yet its radius of curvature cannot be reduced below that of a ring of five carbon atoms without encountering resistance; there will, therefore, probably be a considerably greater resistance to the approach of the double bond to the water in the case of the "trans" form than in the case of the "cis."

The results obtained point clearly, I think, to a greater tendency to occupy the larger area with oleic than with elaidic acid, and a larger with erucic than with brassidic acid. Oleic acid, when first put on distilled water and a compression of about 1·4 dynes per cm. applied to the film, occupies about 40×10^{-16} sq. cm. per molecule; the area decreases steadily with time, however. Elaidic acid occupies about 30 units of area at the earliest moment when readings can be taken, and the area diminishes rapidly to about 22 units, when the film behaves like one of palmitic acid.

In the 22-carbon series there appears to be a smaller tendency than in the 18-carbon series for the double bond to approach the water. Erucic acid gives films rather similar to elaidic acid, but brassidic acid occupies the greater area for so short a time that the curves of compression of the films are not very different from those of a saturated acid such as palmitic.

It is hoped to amplify these experiments and publish full details later.

N. K. ADAM.

Trinity College, Cambridge, May 28.

Sources and Sinks.

LORD KELVIN in a paper "On the Forces Experienced by Solids Immersed in a Moving Liquid" (Proc. Roy. Soc. Edin., 1870) compared two tubes, with liquid flowing through each, with two hard steel magnets and stated that the forces are opposite in the two cases; unlike poles attracting and like poles repelling in the magnetic system, while in the hydrokinetic there is attraction between like ends and repulsion between unlike.

That two sources of like sign attract and two of unlike sign repel, as here stated, is generally accepted. An examination, however, of the case of a source and an equal sink appears to contradict this. When source and sink coincide the fluid medium is at rest, but when they are separated it is in motion and possesses kinetic energy. Work, therefore, must be done to effect the separation. This suggests that the force between source and sink is one of attraction. That this is actually the case is shown by the following experiment.

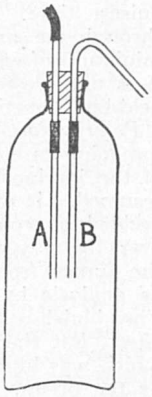

FIG. 1.

Two glass tubes A and B (Fig. 1) are connected by short lengths of rubber tubing to short tubes, which pass about 1 cm. apart through a cork in the neck of a Winchester bottle full of water. The tube A is connected to a water-supply and its open end constitutes an experimental source. The end of the tube B is an equal sink. The source and sink attract smartly and the ends of the tubes remain in contact so long as the water flows.

A. F. DUFTON.

The Royal School of Mines, South
Kensington, May 25.

Polarisation Phenomena in an X-ray Bulb.

HITHERTO the potential difference required to produce a discharge through a well-exhausted vacuum tube has been considered to vary only with the pressure of the gas. In the course, however, of some experiments with an X-ray bulb (where the pressure

could be regulated by a Gaede pump and measured by a McLeod gauge) a continuous discharge was maintained for about eight hours on several consecutive days, and I have observed a gradual hardening in spite of the maintenance of a comparatively high pressure. Further experiments carried out in this direction have revealed a remarkable effect which takes place in an X-ray bulb or, more generally, in any vacuum tube after a sufficiently long and continuous run—an effect similar to the polarisation of an electrolytic cell. This is, that after the discharge has been kept running for a sufficiently long time through a tube (inside which the pressure is kept nearly constant) a time arrives when the current flowing through the tube begins to decrease, and finally ceases altogether. To continue the discharge it is then necessary to increase either the potential difference applied to the electrodes or the pressure inside the tube. By repeating this operation several times I could ultimately reach a stage where a potential difference of more than 50,000 volts was not sufficient to produce a discharge in the bulb, although the pressure was as high as 0·060 mm., whereas under ordinary conditions in the same bulb a much smaller potential difference was sufficient to produce a discharge under a pressure of the order of 0·001 mm. After the discharge has been stopped the bulb gradually returns to its normal condition, but afterwards a comparatively short run is sufficient to bring the bulb back to the state of polarisation.

It could be further shown that the effect is not due to changes in the nature of the gas in the bulb brought about by the discharge. A large side-tube containing two electrodes, the shape and distance apart of which were essentially the same as in the X-ray bulb, was fused into it. When after a long run the main bulb became polarised, so that the highest available voltage could not break down its resistance in spite of a high pressure of about 1/20 mm., a potential difference of 1200 volts, supplied by a battery of small cells, when put across the side-tube was found to produce a normal discharge.

Experiments, which will be described elsewhere, give some evidence in support of the view that this effect is due to the destruction by the discharge of the gaseous layer on the surface of the electrodes.

It seems probable that the hardening of an X-ray bulb with usage is due not only to the disappearance of the gas in the bulb, but also to the phenomenon described in this letter. S. RATNER.

The Physical Laboratory, Victoria University, Manchester, June 1.

Observations of Plant-growth with the Recording Ultramicrometer.

AT the meeting of the Royal Dublin Society on January 25 last, as reported in NATURE for February 24, p. 850, I described a form of ultramicrometer in which the minute movement of one plate of a parallel plate condenser, forming part of a thermionic-valve oscillating circuit, is recorded by a galvanometer. We are now applying this apparatus to the study of plant-growth, and as some of the preliminary observations show very clearly the pulsations of growth described by Sir J. C. Bose, it may be of interest to give a short account of these results.

In applying the method to this problem the upper plate of the condenser is a thin aluminium disc, about 6 cm. in diameter, supported by a long flat strip of spring steel, so as to be situated about 1/10 mm. above the lower fixed (horizontal) plate. The latter plate may be given small vertical movements by means of a micrometer screw for adjustment or calibration of the apparatus. In many of our observations the apparatus is adjusted to give 150 divisions on the galvanometer scale for a displacement of the upper plate through 1/1000 cm., but it can be made many times more or less sensitive simply by altering the galvanometer shunt.

To the recording (upper) plate is rigidly attached a short wooden arm against which the plant member presses lightly. It is found that a weight of 1/10 gram placed on this causes a galvanometer deflection of 100 divisions. This indicates the order of magnitude of the stress on the plant under observation. During experiments on roots the root-tip presses

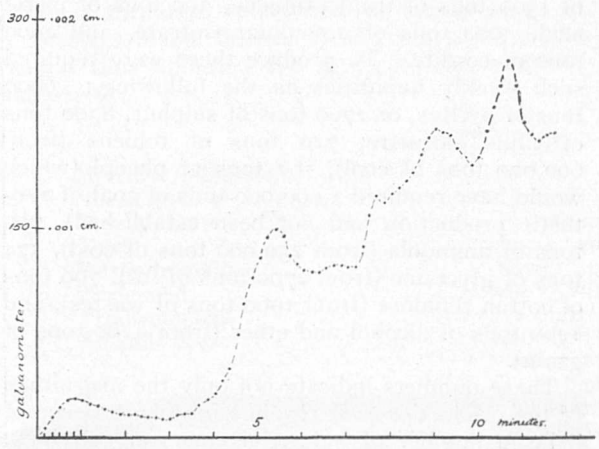

FIG. 1.—Broad bean root-shoot (four days old).

the plate downwards; in other cases the movement is upwards.

As an example of one type of record obtained the accompanying curve is appended. It represents the (downward) growth of the root-shoot of a broad-bean which had been planted some four days before and had just been removed from the ground. A considerable time had been allowed to elapse after placing the plant in position before observations were commenced.

I have to thank two botanical students, Miss Cannon and Mr. Saunders, for the part they are taking in the work. JOHN J. DOWLING.

Department of Physics, University College, Dublin.

Cup and Ring Markings.

REFERRING to the note anent the above which appeared in NATURE of June 9, p. 468, may I mention that these peculiar surface-features can frequently be seen upon old mortar, stucco, and calcareous sandstones, and that they are due to molecular re-arrangement of the calcium carbonate, and not to any artistic efforts on the part of prehistoric man, as is frequently supposed?

At the Royal Society in 1896 I exhibited photographs of some remarkable examples of "cup and ring markings" which had developed on the stucco of one of the houses in Warrior Square, St. Leonards-on-Sea. Similar "patterns" may sometimes be seen on old "American cloth" which has been subjected to tension, and also on old oil paintings. In these cases the gradual shrinkage of the canvas backing has produced the effect by causing lines of fracture in the more homogeneous layers of paint.

June 11. C. CARUS-WILSON.

Some War Developments of Explosives.[1]

By SIR ROBERT ROBERTSON, K.B.E., F.R.S.

IT is not proposed to describe the great factories that arose during the war for the manufacture of explosives, but to indicate by one or two examples some of the conditions which led to developments.

PRODUCTION.

The enormous weekly production was reached of 1500 tons of trinitrotoluene, 300 tons of picric acid, 3000 tons of ammonium nitrate, and 2000 tons of cordite. To produce these were required such weekly quantities as the following: 6600 tons of pyrites, or 2700 tons of sulphur, 8300 tons of Chile saltpetre, 720 tons of toluene (from 600,000 tons of coal), 162 tons of phenol (which would have required 1,000,000 tons of coal, if synthetic production had not been established), 700 tons of ammonia (from 250,000 tons of coal), 374 tons of glycerine (from 2700 tons of fat), 700 tons of cotton cellulose (from 1060 tons of wastes), and 1200 tons of alcohol and ether (from 4200 tons of grain).

These numbers indicate not only the magnitude of the production, but also the interdependence of a large number of industrial chemical activities, and, although many of the products were derived from our own coal, it brings home the dependence of the country on overseas transport of many of the essential substances, such as pyrites, sulphur, Chile nitrate, and cotton.

FIRING AND DETONATION OF A SHELL.

The Propellant.—The processes for the manufacture of cordite and of its ingredients had been the subject of study, and considerable advances had been made, so that it might fairly be claimed that this country led the way in the technique and safety precautions involved in the manufacture of propellants. The existing factories were also capable of extension, until the demand became so great that additional ones had to be erected.

At first, the propellant used was cordite M.D., composed of nitroglycerine, guncotton, and mineral jelly, in which acetone was used to gelatinise the guncotton. A nitrocellulose powder obtained from America was also used. The demand for propellant to be made in this country ultimately reached 1500 tons a week, and this, even with an efficient system of acetone recovery, would have involved an expenditure of that solvent of above 400 tons a week. On account of the shortage of supply of this solvent, a new propellant for the Land Service was introduced—cordite R.D.B.—in which ether-alcohol was substituted for acetone as a solvent, a change necessitating the choice of a nitrocellulose of a lower degree of nitration than guncotton, and alterations in the proportions of the other ingredients. For the new propellant the conditions were laid down and met that it should have the same heat energy, that it should give the same ballistics as cordite M.D., in order to avoid alteration in calculating ranges from data obtained with the older propellant, and that it should be capable of being manufactured by the machinery available and with the technique of manufacture known in the country.

The main changes introduced were in the manufacture of the nitrocellulose and in the supply of the solvent. As ether-alcohol is a less powerful solvent than acetone, even for the special nitrocellulose employed, a strict definition of the nitrocellulose was necessary, and the necessity to provide this in suitable form led to much investigative work on the nature of the cellulose, with the result that its manufacture was brought under a system of strict chemical control. This control had among its objects the elimination of ligneous impurities and the standardisation of the viscosity of the cellulose, since if its viscosity were uniform and low, it was found that the gelatinisation of the nitrocellulose when incorporated with the nitroglycerine and mineral jelly was greatly facilitated, and the production of uniform cords assisted. Ligneous matter in the cellulose was rendered visible by a process in which the woody matter was selectively dyed, and the viscosity of the cellulose was measured by the rate of fall of a steel sphere falling through a solution of cellulose.

The supply of alcohol was obtained entirely from the distilleries of this country, and a large plant for converting a portion of it into ether was erected at Gretna. Nearly 1000 tons of alcohol, or the equivalent of about 200,000 gallons of proof spirit, were required for the production of the 1500 tons of R.D.B. cordite a week, and this requirement it was which led to the restricted sale and increased cost of whisky.

THE HIGH EXPLOSIVE SHELL.

Prior to the war the Land Service used for the most part shrapnel shell, designed to project a shower of lead bullets, efficacious against *personnel,* but of little value in attacking fortified positions, for which high explosive shell are required.

Shrapnel was very largely used by the Land Service throughout the war, but the earlier type of high explosive shell filled with lyddite (picric acid), and brought to explosion by the ignition of a fiercely burning mixture, was abandoned for one in which true detonation was secured with certainty. The latest type of high explosive shell was exemplified by a 4·5-in. howitzer shell fitted with a graze fuze (Fig. 1).

The Fuze.—A graze fuze is a mechanism which gives rise to a flash when the shell grazes on

[1] Summary of a Friday evening discourse delivered at the Royal Institution on May 6.

the ground. It must be capable of being handled roughly without firing, and must not act when the considerable forces involved in firing it from a gun are impressed upon it and upon all its parts. The magnitude of these forces is illustrated by the fact that a fuze weighing 2½ lb. when fired from an eighteen-pounder gun weighs about 11 tons—the stress corresponding to 15,000 times the acceleration due to gravity. These forces are taken advantage of to render the fuze "live"—that is, to put it into a condition when it will act on the slightest provocation.

In the interior of the fuze is a brass cylinder with an axial hole, on the top of which is placed a capsule containing a highly sensitive flash composition. To prevent this cylinder from moving forward in handling, a bolt lies athwart its top edge, and this bolt is retained in this position by a small pin placed vertically at the back of the bolt and having its base pressed upward by a spring working in a vertical cylindrical cavity. On firing, this pin, weighing 1·3 grams, is acted on by a force equivalent to 20 kg., overcomes the resistance of its spring, and recedes into its cavity. The force due to the shell's rotation causes the bolt to fly outwards, thus freeing the brass cylinder, which now is prevented from moving forward on to a needle only by the interposition of a light spring. The fuze is now "live," and on the slightest check being given to the forward movement of the shell, as, for example, by grazing on soft earth, the cylinder moves forward by its own inertia on to the needle, which pricks the capsule, causing a jet of flame to pass down the centre of the fuze. The object of all this mechanism is to supply at the proper time a flash for operating the next member, the gaine, where it gives rise to a detonation.

The Gaine.—This is a tube (from French *gaine*, a sheath) with steel walls of quarter-inch annulus. In its upper portion is a pellet of gunpowder which is ignited by the flash from the fuze, and sends a larger flash on to an open capsule containing fulminate of mercury situated over pellets of tetryl. The fulminate detonates, and in turn causes the tetryl to detonate, and to deliver from the bottom end of the gaine a very intense blow to a series of explosive intermediaries which communicate the detonation to the main bursting charge.

Intermediaries.—The first of these is a bag of T.N.T. crystals situated in a thin steel container tube which encloses it and the gaine. This T.N.T., on detonation, brings to detonation an annular layer of T.N.T. cast round the container, and this in turn brings about the detonation of the main charge of the shell. The train of detonation is thus somewhat complicated, and in its evolution many important principles had to be observed.

Sensitiveness and Violence.—Thus the sensitiveness of the various explosives used had to be determined, since, on account of the magnitude of the acceleration imparted to all parts of the shell on firing it from a gun, a column of a sensitive explosive over a certain length and weight will be liable to detonate on account of the sudden force applied. In proportion to their sensitiveness to mechanical shock, therefore, explosives in shell must be graduated in regard to length of column employed. A general principle is to have next to the detonator a somewhat sensitive explosive, and to reinforce the impulse derived from it by one less sensitive, but still delivering an intense blow. It is important, therefore, to have quantitative values for the sensitiveness of explosives to mechanical shock, and some of the values thus obtained are given in the following table:—

	Figure of insensitiveness (Picric acid=100)
Mercury fulminate	10
Nitroglycerine	13
Dry guncotton	23
Tetryl	70
Tetranitroaniline	86
Picric acid	100
Trinitrotoluene	115
Amatol 80/20	120

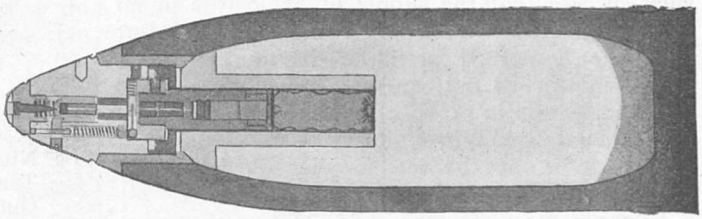

FIG. 1.

It is important also to know the violence of the various explosives used, both by themselves and also when assembled in the various components, and it was in this connection that the principle of the pressure bar, enunciated by the late Prof. Bertram Hopkinson in a discourse to the Royal Institution in January of 1912, was of the greatest value. This depends on the experimental resolution of the momentum of the blow into pressure and time. When a charge is fired against the end of a cylindrical steel bar ballistically suspended, a wave of compression travels along the bar and is reflected at the far end as a wave of tension. To investigate the properties of the wave, a short length of the end of the bar farthest from the end to which the blow is delivered is cut off and the faces are surfaced, the short piece (known as the time-piece) being caused to adhere closely to the bar, usually by a film of vaseline. The compression wave travels unchanged through the joint into the time-piece, but the reflected tension cannot pass through it. Hence when the amplitude of the reflected tension wave reaching the joint becomes greater than that of the oncoming compression wave, the time-piece is projected from the shaft with a momentum which depends on the pressure exerted by the explosive

and the time taken by the wave to traverse the length of the time-piece. This momentum is measured by catching the time-piece in a ballistic pendulum, and, the velocity of the propagation of the wave through steel being known, the mean pressure exerted during an extremely small time interval can be calculated.

(One of the instruments for determining the pressure developed by a detonator was shown, and a detonator fired, the mark drawn by the swing of the pendulum which caught the time-piece being shown on the screen.)

The application of this apparatus not only gave important information as to the limiting quantity of fulminate necessary to bring about complete detonation of the tetryl and as to the effect of the thickness of the wall of the gaine, but it also emphasised the necessity for avoiding gaps in the train of detonation on account of the very rapid falling off in violence of the blow when even a small air-gap is introduced.

Main Filling.—It was early recognised that the supply of picric acid and T.N.T. by itself would be quite insufficient. It was at this point that the late Lord Moulton took steps to secure supplies of essential explosives and their ingredients, with such success that the supply of explosives in no long time came to be ahead of the demand. But even when a method for the production of T.N.T. had been worked out, and its supply on a fairly large scale was in prospect, it was apparent that the demand for high explosive was such that it could not be met by the supplies of nitro-compounds in sight.

Experiments were then made to test the capabilities of mixtures of ammonium nitrate and trinitrotoluene for shell filling, and these gave much promise from the start. They were found to possess the requisite degree of inertness and insensitiveness to enable them to withstand setback on firing from a gun, to have a high rate of detonation, and when detonated in a shell, as was done first in March, 1915, to give evidence of the required violence necessary to fragment the shell.

The first mixture (later termed amatol 40/60, these being the proportions of ammonium nitrate to T.N.T.) was capable of being poured as a thick porridge into shell, and so presented few difficulties for large-scale production. This was at once followed up by similar experiments with a still greater proportion of ammonium nitrate, up to that which is practically the theoretical one for complete combustion of all the carbon of the trinitrotoluene to carbon dioxide, and of all the hydrogen in both substances to water. This explosive, amatol 80/20, was fired in a shell in April, 1915, and gave excellent results. Its explosive properties, as regards insensitiveness, stability, and tests for power, were satisfactory, and it was almost immediately approved as a Service explosive.

Amatol 80/20.—The development of amatol 80/20 was slower. Prepared originally on the large scale by bringing together the finely powdered ingredients in a mixing machine, or by grinding them under edge-runners, 80/20 amatol was ultimately most readily produced by taking advantage of the plasticity of the heated mixture due to the trinitrotoluene melting. Hydraulic presses were used for introducing the powdered or ground explosive into shell; for the plastic 80/20, a worm feed was found expeditious and rapid.

In the course of the manufacture of the enormous quantities of these substances many points of interest and of difficulty arose, which were solved by the assistance of more and more scientific investigators.

The following tables give some data on the explosive properties of the amatols in comparison with some other explosives:—

Heat of Detonation and Gases Evolved.

	Calories per gram (water gaseous)	Total gases c.c. per gram
Picric acid ...	914	744
Trinitrotoluene	924	728
Amatol 40/60 ...	920	892
Amatol 80/20 ...	1004	907
Tetryl	1090	794
Guncotton ...	892	875
Nitroglycerine	1478	713

Rates of Detonation.

	Density of loading	Metres per second
Nitroglycerine ...	(Liquid)	8000
Tetryl	1·63	7520
Guncotton (dry) ...	1·20	7300
Picric acid	1·63	7250
Trinitrotoluene ...	1·57	6950
Amatol 40/60 ...	1·55	6470
Amatol 80/20 ...	1·50	5080

Pressures developed by Ammonium Nitrate, Amatols, and T.N.T.

Ammonium nitrate	Trinitrotoluene	Tons per sq. in. in $0{\cdot}5 \times 10^{-5}$ sec.
100	0	12·5
99·5	0·5	15·2
99	1	18·3
98	2	20·0
95	5	25·2
90	10	30·5
80	20	38·1
40 (at density 1·55)	60	53·9
0 (at density 1·55)	100	55·0

It will be seen that the addition of 40 per cent. of ammonium nitrate to T.N.T. does not markedly reduce its heat value, rate of detonation, or pressure developed, and that amatol 80/20 has a high content of heat energy, but a rate of detonation and pressure lower than T.N.T. itself. It is, however, still sufficiently violent to fragment shell satisfactorily, and the somewhat slower development of the pressure, together with the high calorific value of the explosive, may be of advantage in enabling the fragments to acquire a

higher velocity. It will also be observed that ammonium nitrate itself under a powerful initial impulse gives rise to a notable pressure, so that that ingredient is not to be looked on as a diluent of the T.N.T., but as an explosive substance, as well as a purveyor of the oxygen in which T.N.T. is deficient.

Smoke.—For the purpose of correct ranging and locating the position of burst, an explosive developing smoke is desirable. Amatol 80/20, when used alone, had the disadvantage that it gave no smoke, as the products of the detonation are colourless gases, thus :—

$$2C_7H_3N_3O_6+21NH_4NO_3=24N_2+47H_2O+14CO_2\ ;$$

whereas, when picric acid or trinitrotoluene detonates, a large quantity of unconsumed carbon is set free, affording a black cloud useful for the purpose of observation.

Mixtures capable of producing a white smoke, useful for aerial observation, were then added, and as a result of investigations as to the best method of securing its dissociation, ammonium chloride in conjunction with the ingredients of amatol was localised at the base of the filling.

Needless to say, there were many other developments in explosives practice during the war, but the example of the train of detonation leading up to the complete detonation of a high explosive shell was chosen to exemplify the subject of this discourse, since it included many features and new problems which had an intimate connection with the technical development of the subject.

To secure the high percentage of detonations that our artillerists obtained with the freedom from prematures which they always demanded, it was necessary to have each part of the somewhat complicated train as nearly perfect as possible not only in design, in order to withstand the effects of rough usage and of set-back in the gun, but also in workmanship, both mechanical and chemical as to purity of materials. This was achieved by the co-ordination of a large number of industries organised on a scientific basis, and these were becoming every day more and more efficient. War is now so highly organised that for its successful prosecution all the technical industry of the country is brought under requisition, and to succeed requires a higher development in research, applied methods, and industrial progress than belongs to the enemy.

The effort made by this country in the time of stress to overcome deficiencies in these respects was successful as a great technical achievement, and should be an encouragement to us to look forward to an equal development of our scientific industries under the stress of a competitive peace.

Stellar Parallax.[1]

By SIR FRANK DYSON, F.R.S.

IN the past ten years a number of the large telescopes of the world have been applied to the determination of stellar parallax. The principle of the method is well known and is extremely simple, merely consisting in the detection of the small annual movement of a near star with reference to more distant stars caused by the different position occupied by the observer in consequence of the earth's annual revolution round the sun. The whole difficulty consists in the extreme minuteness of the angle to be measured. If two railway lines, starting at King's Cross, instead of remaining parallel, met at Newcastle the angle between them would be of the order of the angle to be measured in finding the distances of the nearest stars. To form an idea of what is now being done by large telescopes using photographic methods, imagine two plumb-lines 5 ft. apart. They are sensibly parallel, but actually meet at the centre of the earth, and the angle between them is 0·05″. An angle of this size is measured with an accuracy of ±0·01″. Results of this high value were first obtained by Prof. Schlesinger at the Yerkes Observatory. At the present time the observatories of Allegheny, Greenwich, McCormick, Mount Wilson, Yerkes, and a number of others are engaged on a comprehensive programme. At Greenwich we determine the parallaxes of fifty stars a year; at some of the American observatories many more.

Necessarily, a good deal of care is required both in taking the photographs and in measuring them. The image of a star may have a diameter of 2″ or 3″, and the position of its centre should be measurable to between 1/50th and 1/100th of this amount. The methods of measurement present some points of interest which need not be described now, but a word or two about the precautions to be observed in taking the photographs may be of interest. The images must be as circular and uniform as possible. (1) The guiding of the telescope must be as perfect as possible. (2) The lenses of large object-glasses must be adjusted with great care so that there may be neither tilt nor eccentricity between them. (3) Photographs should all be taken with the telescope pointing in the same direction. One cannot be taken when the field is east and another when it is west. Atmospheric dispersion and possibly minute flexure of the lenses cause slight deformation of the images which may be scarcely visible to the eye, but appear in measures. (4) The star the parallax of which is being determined and the comparison stars should have approximately

[1] From a discourse delivered at the Royal Institution on Friday, April 29.

equal images on the photograph. This is secured by means of a rotating shutter, a neutral screen, or the use of a grating in front of the objective.

The purpose of (3) and (4) is to make any residual errors the same for the parallax star and the comparison stars, and so far as possible the same on all photographs.

The knowledge of the distance of a star gives us immediately its luminosity or the amount of light it emits as compared with the sun. There is a very great range in luminosity even for stars of the same spectral type. Now the stars have been arranged in an order according to the spectra, which agrees fairly well with their order in colour from blue to red, and is essentially an arrangement according to temperature. This may be regarded as an extremely good first approximation to a classification of stellar spectra. But it does not detect any differences attributable to absolute luminosity, though presumably density and gravity at the surface layer of the star from which the lines in the spectrum have their origin must be widely different.

A few years ago a very fruitful investigation was commenced at Mount Wilson by Adams and Kohlschuter. By a close comparison of the spectra of stars of the same spectral class, but differing greatly in absolute luminosity, they detected lines the intensities of which differ. Adams and his coadjutors at Mount Wilson have pursued this research with very great success. They have found in stellar spectra a number of pairs of neighbouring lines, one line of each pair being independent of the absolute luminosity, while the other changes in intensity with the luminosity of the star. They have measured the relative intensities of these pairs of lines, and compared their measures with the luminosities of 650 stars already known through the trigonometrical determinations of parallax made at Allegheny, McCormick, Mount Wilson, and Yerkes. Thus they have found the luminosities of stars corresponding to different intensities of the lines. They have recently published a catalogue (*Astrophysical Journal*, March, 1921) giving the luminosities and parallaxes of 1680 stars.

The advantage of this method is that it extends the range of parallax determinations beyond the limit (say) 0·02″ of the trigonometrical method, the limit of the spectroscopic method being determined only by the capacity of large telescopes to give measurable spectra. In the table a comparison is given with unpublished results at Greenwich obtained by the trigonometrical method :—

No.	App. mag.	Mag. at 10 parsecs	Parallax	
	m.	m.	Mount Wilson	Greenwich
			″	″
B 1673	5·6	4·2	0·052	0·034
B 2897	6·1	4·3	0·044	0·040
B 2971	7·8	7·2	0·076	0·088
C 1604	8·2	4·9	0·022	0·015
B 3983	6·9	5·7	0·058	0·052
B 4181	5·0	1·7	0·022	0·041
B 4234	6·4	2·4	0·016	0·013
C 2242	7·6	5·4	0·036	0·046
B 4322	4·8	3·6	0·058	0·031
B 5009	4·8	3·8	0·158	0·171
B 6129	6·6	6·7	0·105	0·076

Comparison of these results, obtained by entirely different methods, shows the accuracy of 20 per cent. claimed for Mount Wilson, and ±0·010″ for Greenwich is reached.

A third method is being employed extensively for determining stellar distances depending on the fact that the masses of stars lie within very restricted limits. It is applicable only to double stars, and depends on Kepler's third law, $M+m=a^3/P^2$, where M, m are the masses, a is the mean distance between the components, and P the period of a double star. When P is known and $M+m$ assumed, a is found, and, further, as the cube root of $M+m$ is involved, an error in the assumed mass produces a much smaller error in the mean distance. Now the *angular* mean distance is determined by direct observation for all double stars the orbits of which can be calculated. At the present time this amounts to more than 150. But it has been shown by Hertzsprung and Russell that for double stars which have completed too small a portion of their orbits for their periods to be known it is still possible to obtain their "hypothetical" parallax with considerable probability. The method has been recently applied at Greenwich to obtain the parallaxes of a large number of stars, and the accordance with the results found by the trigonometrical and spectroscopic methods is very satisfactory (see a paper in Monthly Notices R.A.S., November, 1920, by Messrs. Jackson and Farmer).

I believe there is in preparation by American astronomers a catalogue giving the parallaxes of 3000 stars, about half of which have been determined by two at least of these three methods. We may expect that in the course of a very few years the distances of all stars visible to the naked eye in the northern hemisphere will have been determined, as well as those of many fainter stars. This great accession of knowledge of stellar distances carries with it a corresponding increase with reference to the luminosities, sizes, masses, densities, and velocities of stars of different spectral classes.

Obituary.

WILLIAM WARDE FOWLER. 1847–1921.

WARDE FOWLER, like Arthur Sidgwick, was one of the men we can least spare—a classical scholar of distinction and a writer of great charm who sympathised warmly with the aims and methods of science, and strove to give them a larger place in the life of his University. It would scarcely be possible to gain a clearer insight into the strength and weakness of an Oxford education as it was nearly twenty years

ago than by reading his "Oxford Correspondence of 1903" (Blackwell, Oxford; Simpkin, Marshall and Co., London) between a college tutor and one of his pupils whose eyes are opened to the meaning of research by meeting a Zürich Professor in the Long Vacation. Warde Fowler's opinions and the long experience on which they were based appear in the charming letters of the tutor. We owe it to him and many others like him in this respect that the years since 1903 have brought a steady growth in the amount of original work and in the significance attached to it by the University.

In the brief space available I do not propose to say more of Warde Fowler's writings, excellently described in the *Times* of June 16, than just this—that he brought to his classical work the spirit of the naturalist, always seeing through the beautiful veil of literature to the everyday human lives and interests that lay behind, and as he delighted in them himself, so he made them a delight to others.

He was a most interesting and arresting lecturer, and had the supreme gift of selecting and describing an observation so that it both illuminated and fixed in the mind some far-reaching conclusion. No one could forget that the lines of bird-migration are determined, and may be varied, by sight and memory, after hearing him tell of the misty autumn day when he stood on the chalk cliff near Swanage and watched the little bands of swallows arriving from the west and flying round the English coast to the north of the Isle of Wight, on their eastward journey, to cross near Dover; and lo! as he stood watching, there suddenly arrived a band which acted very differently, circling up into the air and darting directly eastward across the sea; and then, following their flight, he saw for the first time what they had seen, that the mist had lifted and the Needles were in sight. Then, and then only, had they taken the direct and shortest eastward route along the chalk midrib of the Isle of Wight.

Or he would tell of the thrush that, in the middle of its song, saw one of its young carried off by a cat, and expressed its emotions by singing more loudly and passionately.

Or it was the want of attention in observation that was illustrated by the fishermen, he being one of them, who, after their day's sport was over, began discussing the position of the fins of the trout, and, unable for the life of them to remember the arrangement, paid a visit to the larder to find out!

It is interesting to compare with this experience the unconscious yet keen attention and the sure memory which come into play when man observes his fellow man. And this is to be expected. There have been long periods when the recognition of a man by his shoulder or head seen from behind, or by his gait, has meant the difference between life and death.

The memories I have recalled belong to the early days of the Ashmolean Natural History Society of Oxfordshire, and probably all are more than thirty years old. The charm and arresting personality of the speaker have left them clear and bright.

E. B. P.

R. E. DENNETT.

MR. R. E. DENNETT, who died in London on May 28 at the age of sixty-four, was a student of the religions, languages, and customs of the indigenous races of West Africa, and his work was marked by great ability and originality. Son of an Anglican clergyman of unusual individuality—a Devonshire man—Mr. Dennett was born at Valparaiso, and had his early education at Marlborough School. He went out to West Africa in his early twenties, and he spent more than forty years in Nigeria and in what are now the French and Belgian Congo territories. Comparatively early in his career he was brought into association with that remarkable woman, Mary Kingsley, and his mind, already sympathetically disposed towards the native races, received an additional powerful impetus in the same beneficent direction. Thereafter he bent a great part of an intellect naturally strong to the attempt to interpret the character and institutions of the Africans to the reading public in Great Britain.

Mr. Dennett had special opportunities for observation, for in turn he was trader, explorer, and official, a combination not often found in one person. It was (indeed, still is) work highly necessary, for it is probably safe to say that the main impression left upon the minds of most people in Britain as the result of reading the accounts of the Stanley expeditions was that all Africans are absolutely primitive and all at the same stage of development. Nothing could be more grotesquely inaccurate, and Mr. Dennett's careful, patient, above all sincere and sympathetic, researches did much to make clear the truth, which is, of course, that the greater facts of man's life are represented among Africans by institutions and observances much the same in root significance as those of Europeans, but in some respects less highly developed. He believed firmly that the most hopeful course in British West Africa was, while suppressing accompaniments of native rule which are inconsistent with individual rights, carefully to preserve and support the main body of African custom, which he held to be essentially just and based upon the life and needs of the people. That is to say, he wished the African to be governed by his own people in his own way, the European Powers keeping the peace while the native races gradually advanced along their own lines.

Of several noteworthy books that by which Mr. Dennett will best be remembered is probably "At the Back of the Black Man's Mind," a close and penetrating study of the great subject indicated by the title. Others are: "Seven Years among the Fjort," "Nigerian Studies," "My Yoruba Alphabet," "Universal Order," and "Periodic Law." One of the most painstaking of inquirers,

Mr. Dennett was also one of the most genial and simple-natured of men, and his death will be most deeply regretted by a wide circle here and in Africa. C.

SIR THOMAS WRIGHTSON, BART., M.INST.C.E.

SIR THOMAS WRIGHTSON, BART., a master of industry in the North of England, died at Neasham Hall, his seat on the banks of the Tees, on June 18, in the eighty-second year of his age. Like his cousin, the late Lord Armstrong, in whose Elswick works he served his apprenticeship, Sir Thomas combined a business aptitude with the qualities which go to make a research worker and inventor. He contributed numerous papers on professional and technical subjects to the Proceedings of engineering and metallurgical institutes and societies with which he was associated, but of his contributions to knowledge the one which is most likely to be remembered is connected with a pastime rather than with his profession. He was an ardent musician in his earlier years, and became interested in the power possessed by the human brain of resolving compound sound-waves into their component notes. He was not satisfied with the theory put forward by von Helmholtz in 1863, and in 1876, when giving a presidential address to the Cleveland Institution of Engineers, he put forward an observation which he afterwards made the basis of a new theory of the mechanism of hearing. This observation was that if the sine curves representing a compound sound-wave are plotted out on a zero line, and if it is supposed that each crest, trough, and "crossing point" on such a tracing could give rise to a stimulus on entering the ear, the time intervals of all the primary component notes could still be recognised. The cochlea, he supposed, must be able to detect these as pressure pulses, and acted not as a resonator but as an hydraulic apparatus. A little later he became involved in public life and in politics, and sat first for Stockton and afterwards for St. Pancras East in the Conservative interest. In 1906 he abandoned politics to devote himself anew to working out the idea he had first put forward in 1876. In 1907 he published a monograph under the title, "On the Impulses of Compound Sound Waves and Mechanical Transmission through the Ear." In this publication he describes and figures a machine of his own invention—an ohmograph he named it—by which he could combine the tracings of two, three or four simple notes into their combined form. Associating himself with Prof. (now Sir) Arthur Keith, a reinvestigation of the finer anatomy of the cochlea was undertaken, with the result that many facts came to light which were favourable to his interpretation of the mechanism of the internal ear, but could not be explained on the supposition that the cochlea serves as a resonator. In 1918 Sir Thomas brought his evidence together in the form of a book which was published by Messrs. Macmillan under the title, "An Enquiry into the Analytical Mechanism of the Internal Ear." The theory thus put forward is at present being subjected to a searching criticism, and if it be too much to claim that anything like finality has been reached, it may be safely stated that the author has made a contribution which has a permanent value for students of auditory mechanism.

Notes.

THE formal opening of the new Intermediate Scale Chemistry Laboratory of the Imperial College of Science and Technology by Mr. A. J. Balfour (the Marquess of Crewe presiding) will take place tomorrow (Friday) at 4 o'clock.

THE annual general meeting of the Research Defence Society will be held at 11 Chandos Street, W.1, on Wednesday, June 29, at 3.30, under the chairmanship of Lord Lamington. Dr. H. H. Dale will give an address on "The Work of the National Institute for Medical Research."

THE Semon lecture for 1920–21 in connection with the University of London will be given at 5 o'clock on Tuesday, July 5, at the Royal Society of Medicine, 1 Wimpole Street, W.1, by Dr. J. Horne, who will take as his subject "The Relationship of the Larynx to Pulmonary Tuberculosis." Admission will be free, without ticket.

A BILL to provide for the time in the British Isles being in advance of Greenwich mean time during a certain period of the year has been presented to the House of Commons.

THE president and council of the Royal Society have appointed Mr. H. Robinson, of the University of Manchester, to the Moseley studentship for research in molecular physics, the funds for which were bequeathed to the Royal Society by the late Lieut. H. G. J. Moseley.

THE John Fritz gold medal has been awarded by the National Societies of American Engineers to Mr. Schneider, past-president of the Iron and Steel Institute, in recognition of his work in connection with the development of artillery.

BY the will of the late Sir Felix Semon, the laryngological library of this well-known throat specialist is left to the Royal Society of Medicine.

A GOLD loving-cup was presented on Friday last by the members of the Royal Institution to Sir James and Lady Dewar on the occasion of their golden wedding.

IN consequence of the illness of Dr. J. Rennie, it has been found necessary to suspend the arrangements made by the Ministry of Agriculture and Fisheries for the examination of diseased bees. The Ministry will issue a further announcement as soon as other arrangements have been made.

AT the evening meeting of the Royal Geographical Society on Monday last the president stated that the

society had heard with great regret of the death of Dr. Kellas, who had been invited to join the Mount Everest Expedition that he might carry out on Mount Everest the experiments in the employment of oxygen at high altitudes which he had already planned to carry out this summer on Kamet. It is feared that Dr. Kellas's death may have been due to his own untiring energy, for instead of resting after his great climb last summer he had spent nearly all the winter in climbing peaks in Sikkim.

CAPT. ROALD AMUNDSEN has asked the Storting by telegram from Nome, Alaska, for 300,000 kroner (about 12,000*l.*) for the purpose of refitting his vessel, the *Maud*, in order to enable him to continue his expedition in the Arctic regions. The *Maud* lost a propeller off Cape Serge, and is to be towed to Seattle for repairs.

As already announced, the Congress of the Universities of the Empire will be held at Oxford on July 5–8. In the morning of July 5 the following subjects will be discussed: "The Universities and the Balance of Studies." (1) The place of the humanities in the education of men of science and men of affairs. (2) The place of the physical and natural sciences in general education. (3) The question of specialism in university curricula. In the afternoon: "The Universities and the Teaching of Civics, Politics, and Social Economics." "The Universities and Secondary Education." (1) The frontiers of the secondary school and the university. (2) The influence of university entrance requirements upon the curricula of secondary schools. In the morning of July 6: "The Universities and Adult Education." (1) Lectures for the general public within the walls of the university. (2) Extra-mural work. In the afternoon: "The Universities and Technological Education." In the morning of July 7: "The Universities and Training for Commerce, Industry, and Administration." "The Universities and the Training of School Teachers." In the afternoon: "University Finance." In the morning of July 8: "The Universities and Research." In the afternoon: "Interchange of Teachers and Students." (1) The institution of a Sabbatical year for professors. (2) Provision of temporary junior posts for graduates of Colonial and foreign universities. (3) How to raise funds to make a trust for the promotion of the migration of students. (4) Equivalence of entrance examinations. (5) Mutual recognition of study and examinations.

A NATIONAL exhibition of maternity and childhood has been organised in Paris from June 15 to July 25. The exhibition is located in the Jardin Zoologique d'Acclimatation, Bois de Boulogne, and is divided into five sections. The object of the exhibition is to encourage larger families than at present obtain in France, and in the various sub-sections such subjects as the small birth-rate, its causes and prevention, infantile mortality, and the rearing of large families are dealt with. Conferences, *fêtes*, and sports are included in the programme. A large and influential committee has charge of the organisation, which is under the patronage of the President and Ministers of the Republic, the secretary-general being M. Em. Brocherioux.

A PROVISIONAL programme for the Paris Conference of the Museums Association, to be held on July 12–18, has been issued. The headquarters of the association while in Paris will be the Hôtel Moderne, Place de la République, and the meetings will be held at the Musée National D'Histoire Naturelle, Rue Cuvier. Papers on museum administration and numerous tours of French museums have been arranged, and there will be at least one joint meeting with the French Museums Association. Information regarding tickets, passports, and hotel accommodation, both for those attending the meeting and for those contemplating a more extended tour after the conference, can be obtained from Mr. W. J. W. Barrier, 31, Lime Grove, Shepherd's Bush, W.12.

A CONFERENCE of the International Union against Tuberculosis will be held in London, under the auspices of the National Association for the Prevention of Tuberculosis, on July 26–28. The annual conference of the National Association will be merged in the larger gathering. The object of the International Union, which was founded last year, is to promote an effective combination of the nations of the world against tuberculosis, and its first president is M. Léon Bourgeois. For the occasion of the coming meeting, however, Sir Robert Philip will act as president. Official delegates from countries within the League of Nations, from America, and from authorities interested in the subject, are invited to attend. The principal business of the conference will be a discussion, opened by Prof. A. Calmette, on the modes of diffusion of tuberculosis throughout the races of the world. Sir Humphry Rolleston will open another discussion on the *rôle* of the medical profession in the prevention of tuberculosis. There will be an official reception of the Union by the Lord Mayor of London on July 26, and visits to institutions of particular interest are being arranged.

THE executive committee of the council of the American Association for the Advancement of Science held its regular spring meeting at Washington, D.C., on April 24 last. The business transacted at the meeting is reported in *Science* of May 20, and some of the resolutions will be of interest to men of science in Great Britain. The next meeting of the association will be held at Toronto, and it was resolved that a special committee should collaborate with the local committee for the meeting to invite an eminent British man of science to attend to present papers before the section of the association to which his field of work is related and to deliver a general public lecture. The executive committee of the council also resolved that the British Association for the Advancement of Science be invited to send a representative to the Toronto meeting, and Dr. J. McK. Cattell was elected official delegate of the American Association to the forthcoming Edinburgh meeting of the British Association. A further resolution, which is of great interest in view of the letters which have appeared in our columns on the same topic, asks for the restoration of the privilege of duty-free importation of English scientific works by recognised educational institutions and faculties. The committee also directs the attention of Congress to the burden which would be im-

posed on scientific education and research by the proposal to repeal that part of the Tariff Act of 1913 which permits the duty-free importation of scientific materials, and on behalf of its 12,000 members asks for reconsideration of the suggestion.

A FURTHER step in the movement towards the standardisation of automobile, motor-cycle, and cycle parts has been taken by the British Engineering Standards Association in the formation of seven sub-committees the subjects and chairmen of which are as follows:—Nomenclature, Major C. Wheeler; Steels, Mr. A. A. Remington; Small Fittings, Mr. W. D. Williamson; Electrical Fittings, Mr. E. Garton; Shafts and Shaft Details, Mr. L. A. Legros; Wheels, Rims, and Tyres, Lt.-Col. D. J. Smith; and Cast Iron, Dr. L. Aitchison. Before the sub-committees actually embark upon the detailed work the various organisations concerned are being consulted in order to ensure that the proposed *personnel* meets with their approval as adequately representing their respective interests. In the meantime, technical data in regard to the specific subjects to be taken in hand immediately are being collected, and this should greatly facilitate the progress of the work as soon as the membership of the sub-committees is officially approved.

DR. A. C. HADDON selected as the subject of the Huxley memorial lecture, published in the Journal of the Royal Anthropological Institute (vol. l., part ii.), "The Migrations of Cultures in British New Guinea." He remarks that along the coast a traveller notices a series of cultures, some evidently related to one another, while others are as obviously unrelated. The differences indicate that there is no immediate relation between them, though their affinity points to a common origin. The cultural problems of the south-eastern peninsula and the outlying islands are in the main quite distinct from those of the west, and the differences between these two groups indicate clearly that there cannot have been any extensive cultural movements from the Papuo-Melanesian to the western Papuan. We are driven, on general grounds, to the supposition that the cultures of the southern coast of New Guinea came down more or less from the north. The difficulty is that we have as yet no precise knowledge of the inhabitants of the interior of the island, and the socio-religious customs of the natives of many of the coastal areas have yet to be investigated. The lecture, with its appendix of material, is a valuable contribution to our knowledge of the ethnology of New Guinea.

IT is a significant indication of the change of view in relation to anthropometry that in his paper on "Ancient Skulls from Greenland" Mr. W. E. Le Gros Clark (Journal of the Royal Anthropological Institute, vol. l., part ii.) remarks that many attempts have been made to deal with the various races of man as the zoologist deals with the various species of mammals; to find some specific features which may serve to differentiate the skull of one race from the skull of another, in the same way that the concave post-orbital process distinguishes the skull of a fox from that of a dog. "This method was carried to an extreme by Sergi when he subdivided the Mediterranean Race into a number of varieties, each characterised by the shape of the cranium as seen from above. These attempts have all failed, and it must be realised that the variation of individual skulls of modern races is so great that it is often extremely difficult to assign an isolated skull of unknown origin to a definite race with any degree of certainty." Mr. Clark points out that the construction of a type contour obviates these difficulties, and on its use the future of the science of craniology must depend.

ALL lovers of Oxford will welcome the pamphlet issued by the Clarendon Press in which Mr. H. E. Salter, after an exhaustive study of the college records and other literature, discusses "The Historic Names of the Streets and Lanes of Oxford. Intra Muros." It is remarkable that during the last 900 years only two new streets have been constructed—New Road in 1770, and King Edward Street about a hundred years later. The old lane near Christ Church meadow was called Shulinstoke, the pool above the mill where the cucking-stool was used; The Seven Deadly Sins was perhaps the sign of an inn, or a set of seven small cottages; Bocardo Lane was called after the Bocardo or Town Prison; the Turl was the Twirling Gate on the foot-way which led from Ship Street to Broad Street, and is not, like "The Broad," an undergraduates' abbreviation. Broad Street was known as Horsemonger Street in the thirteenth century, and that running from the west end of Broad Street towards the station was Irishman's Street. The author ends by suggesting that Cat Street should be restored for Saint Catherine's Street, Bocardo Lane for St. Michael's Street, and that Alfred Street should be rechristened Vine Hall Lane.

AT the Royal Society conversazione on June 15 an exhibit was given illustrating the life-history of *Chermes Cooleyi*, Gillette. This insect has been recently observed in Britain. It is spreading rapidly throughout the southern counties of England, and occurs in two localities in Scotland. A study of it is being made by Mr. R. N. Chrystal under the direction of the Forestry Commission with the view of working out its biology and determining its relation to Douglas fir and Sitka spruce plantations in this country.

VOL. LVIII. (pp. 483–576, 1920) of the Proceedings of the U.S. National Museum contains a revision of the Nearctic ichneumon-flies of the genus Apantales by Mr. C. F. W. Muesebeck. As natural controlling agents of injurious insects many species of Apantales play important parts. Thus the larvæ of the common cabbage butterfly, those of the gipsy and brown-tail moths, and many cut worms and army worms are heavily parasitised by these insects. There appears to be no authentic record of an Apantales having been bred from any insects outside the Lepidoptera. In this revision 164 species are known to the author, and a list of their hosts is appended wherever known. On pp. 327–62 of the same serial Mr. R. A. Cushman revises the ichneumon-flies belonging to the tribe Ephialtini, the members of which are internal parasites of Lepidopterous pupæ.

WITHIN a year after the armistice some thirty nations and States agreed to two series of international air maps, the general and the local. The Geographical Section of the General Staff has undertaken the work of those sheets which fall within the British Empire. In the *Geographical Journal* for May Lt.-Col. E. F. W. Lees discusses the proposed maps at some length. For the general map it appears that Mercator's projection, despite all its disadvantages, is to be employed, principally because of its use in navigation and the general training of pilots on naval lines. The scale is to be 3 cm. to 1° of longitude at the equator, and the index is to be based on the index of the international million map. An overlap of 1° of latitude and 3° of longitude is to be allowed. As regards colouring and symbols, some departures must necessarily be made from the conventional usages of maps for terrestrial purposes. Experience has shown what features are of value to the airman in locating his position and finding his way. All water is to be blue; aeronautical information, such as positions of aerodromes, seaplane stations, lightships, etc., black; roads, deep yellow or burnt sienna; railways red, because of their conspicuousness to airmen; and woods green. Red is also to be used for buildings. Hill shading for the depiction of relief on the general map was recommended by the International Convention, but the employment of the layer system does not lack advocates. The general ground colour is to be pale green for ground covered with vegetation and pale buff for arid ground. Names apart from those applying to aeronautical information will be sparingly used. The local maps are to be on a scale of 1 : 200,000. For these the International Convention does not suggest the use of Mercator's projection. An innovation that will cause some criticism is the adoption of a new system of co-ordinate reckoning. Latitudes commence with zero at the South Pole and increase to 180° at the North Pole, and longitudes begin with the present 180° as zero or 360° and run eastward round the sphere. This departure from convention seems to carry no merits beyond the elimination of the letters N. and S. in latitudes and E. and W. in longitudes.

THE Report of the Director, United States Coast and Geodetic Survey, for the year ending June 30, 1920, is of considerable interest on account of the large number of charts it contains, many of which illustrate the extent of hydrographic survey along important steamer tracks on the coasts of America and its possessions. These maps show how much detailed work is required even in much-frequented channels in order to ensure safe navigation. Special emphasis is laid on the need for wire-drag surveys on the rocky coasts of the Pacific States and Alaska. The Director also makes a plea for the survey of Alaska, and shows in several charts and diagrams how little has already been done. Ninety per cent. of the coastal waters are uncharted; where surveys have been made a startling number of dangers to navigation has been discovered. It is essential also that the survey control points in Alaska should be linked up with other surveys of the United States or Canada. Operations have been begun with the co-operation of the Canadian Government for a line of triangulation from Seattle through south-eastern Alaska, the so-called "panhandle," to the Yukon Valley and Bering Strait. The report indicates the progress made in the detailed survey of the Virgin Islands recently acquired from Denmark.

MR. A. W. GILES has studied and mapped the eskers in the vicinity of Rochester, New York, in Proc. Rochester Acad. Sci. (vol. v., pp. 161–240). A very useful bibliography of 126 papers is appended. Mr. J. G. Goodchild's Eden Valley papers (*Geol. Mag.*, 1875, and Quart. Journ. Geol. Soc., vol. xxxi.) might be included, since he was one of the first authors to urge a sub-Glacial origin for gravel ridges. Mr. V. Tanner's detailed description of the Lapland eskers (*Bull. Comm. géol. Finlande*, 1915) might also be added as an elaborate modern study of the deposits of continental ice. Mr. Giles systematically reviews objections to the sub-Glacial theory of eskers, and concludes firmly in its favour. The knolls on esker-crests and the interruptions in chains are accounted for in several reasonable ways, and it is made more than ever apparent that an unnecessary amount of mystery has grown up round the subject since Hummel's explanation was published nearly fifty years ago. Even the nomenclature has become confused, and Mr. Giles's sentence, "The Swedish word 'os,' plural 'osar,' sometimes written 'as (asar),' has priority," contains, unfortunately, two linguistic errors.

THE history of geological research in the United States has been enriched by Mr. G. P. Merrill's "Contributions to a History of American State Geological and Natural History Surveys," a volume of 550 pages, published as Bulletin 109 of the Smithsonian Institution in 1920. Numerous portraits of the pioneers are given, and a great deal of instructive information may be gathered as to the functions of local surveys and their relations to other State Departments. Much of the material was originally collected by the U.S. Geological Survey, which has now permitted publication in this convenient and comprehensive form. The author refers also to Bulletin 565 of that Survey, in which Mr. C. W. Hayes summarised the work of the Surveys of the separate States.

RECENT drainage operations in the Awanui Swamp in North Island, New Zealand, have disclosed the existence of an elaborate drainage system many miles in extent which, there is good reason to think, may antedate both the Maori and their predecessors, the Moriori. The discovery is described by the *Times'* New Zealand correspondent in the issue of June 16. The drains are said to be uniformly about 5 ft. in width and 5 ft. in depth, with regularly sloped sides, the bottom being about $3\frac{1}{2}$ ft. wide. They run for many miles across country in parallel lines perfectly straight, with numerous right-angle cross-drains. An indication of their age is afforded by the fact that in places huge trees of slow growth have grown up in the drains after their formation and decayed. The remains of deeply embedded posts with sharpened ends on a mound in one part of the swamp indicated that

it had been the site of a building. A remarkable piece of carved wood in the shape of a lintel, which was found at a depth of 5 ft., has just been secured for the Auckland Museum. In its centre is represented a human figure "almost gorilla-like in appearance"; it has a broad, wedge-shaped head with projecting ears, small broad nose, and a large oval mouth with small tongue. The body is small, short, and squat. The outstretched hands of the figure rest upon a perforated framework spreading right and left, the ends of which each terminate in a saurian-like head. Water-worn stones of the size of a hen's egg which have human features carved on them have also been found. The antiquity of these remains, as well as their style and technique, would appear to preclude their attribution to either Maori or Moriori.

THE American Association for the Advancement of Science, the National Academy of Sciences, and the National Research Council have appointed small committees which held a joint meeting on April 9 last to consider the problem of the conservation of the natural resources of the United States (*Science* of June 3). A resolution was passed recommending that the committees already in existence should function as a joint committee on national conservation, and at subsequent meetings of the three organisations represented the resolution was confirmed, and funds were provided for defraying the immediate expenses of setting up an executive and secretarial agency for the prosecution of the work. The main objects of the organisation which is to be established are stated under five headings; first, to direct scientific research so that it may bear more directly on the problems of conservation, a consideration which will involve a wide knowledge of the scope of any problem, and its relation to the programmes of research in other fields of work; secondly, the collection of data relating to natural resources, and their interpretation in relation to the economic, industrial, and social welfare of different regions, and of the nation as a whole; thirdly, to introduce the principles of conservation into the curricula of educational institutions; fourthly, to lead a campaign of popular education in the meaning of conservation; and fifthly, to correlate the efforts of existing agencies which are striving for conservation in their own particular fields. We shall await with interest the development of this scheme for economising the natural resources of the United States.

DRY weather has been persistent in England during several months, and now that we are more than halfway through the first month of summer the absence of rain has become serious. The observations at Greenwich, which very fairly represent England, show that the conditions are most exceptional. The Greenwich rainfall was below the normal for each of the eight months from October, 1920, to May, 1921, and compared with the average for 100 years the deficiency of the period is 6·21 in.—approximately equal to the normal rainfall for the four months February to May. There have, however, been only two months, November and February, with the rainfall less than an inch. The total measurement of rain for the eight months is 9·32 in., which is 60 per cent. of the average. An examination of the Greenwich observations for the last 105 years shows only one corresponding period as dry, the rainfall for October, 1879, to May, 1880, amounting to 8·24 in., a deficiency of 7·29 in. October, 1873, to May, 1874, had 9·60 in. of rain, and the next driest was apparently October, 1897, to May, 1898, with 10·50 in. There have been several spring droughts in the last 100 years, and for the four months February to May there have been ten years with the total measurement less than 4 in. This year the measurement for February to May was 3·78 in. The years with the smallest measurements for the corresponding period are 1834 with 2·60 in., 1857 with 2·76 in., 1863 with 2·90 in., and 1874 with 3·16 in. Temperature throughout the past eight months was abnormally high, the mean for each month at Greenwich being above the average and the excess for the whole period 2·3°.

AN interesting paper on the cause of quenching cracks in steel was presented at the May meeting of the Iron and Steel Institute by Messrs. Honda, Matsushita, and Idei. The cause is generally believed to be (1) the non-uniform distribution of temperature in the specimen during quenching and (2) the difference in martensitic expansion of adjacent parts during quenching. A closer examination of the phenomena, however, shows that the true cause is not so evident, for the sound due to cracking is often heard some ten seconds after quenching. In small pieces of steel the periphery is harder than the central portion only in a mild quenching; with a medium quenching the hardness is nearly equal throughout; while with hard quenching the periphery is always softer than the interior. This anomalous phenomenon is explained by the presence of arrested austenite in martensite. The quenching cracks in small pieces of steel occur when the hardness in the central portion is much greater than in the periphery, and they are attributed to the stress caused by the difference in the specific volumes of austenite and martensite. The specific volume of the former is smaller than that of the latter, and hence the central portion exerts a large tangential tension on the periphery. Since the difference in the specific volumes increases as the temperature falls, the cracking usually takes place when the temperature of the quenched specimen approaches that of the room. In a hard quenching the hardness gradually increases with the lapse of time owing to the gradual transformation of the arrested austenite into martensite.

MR. A. S. E. ACKERMANN'S first paper dealing with experiments with clay in its relation to piles was the subject of a note in NATURE for March 27, 1919. In his second paper on the same subject—read before the Society of Engineers in October last—the author takes the opportunity of correcting some errors which appeared in the first paper, and points out that further work has confirmed all the previous conclusions excepting that the effect of temperature on the supporting capacity appears to be limited to stresses below the pressure of fluidity, and that the sides of a hole appear to crush in before the statical

head is equal to the pressure of fluidity. Unquestionably the most interesting of Mr. Ackermann's results is that clay possesses a pressure of fluidity at which the loaded pile sinks through the clay without further increase in the load. This critical pressure depends upon the percentage of water present, being greater with less water. Mr. Ackermann has added to his former work in the direction of experiments designed to separate the work done against frictional resistances from that done in displacing the clay, and finds that the former is by far the larger quantity. A number of experiments have also been made on chalk, and the author finds that wet powdered chalk has a modified pressure of fluidity, and that the water-content affects greatly the properties of chalk. There is a marked difference in the physical properties of powdered chalk as compared with precipitated chalk. The adhesion and cohesion of wet chalk are much less than those of clay; clay is hygroscopic and chalk is not.

THE *Daily Mail* of June 13 published an article by a scientific correspondent under the sub-heading "Can Eyes Radiate Energy?" which gives some account of a new instrument showing that "rays proceed from the eye which are capable of being registered just as wireless messages are detected." Dr. Charles Russ, the inventor of the instrument, writes to us stating that the paragraph constitutes a breach of confidence on the part of someone to whom the instrument was shown. It was intended that the phenomenon should be announced at the Ophthalmological Congress at Oxford on July 7, and some annoyance has been caused to Dr. Russ by this premature disclosure.

MR. A. RISDON PALMER is bringing out through Messrs. George Bell and Sons, Ltd., a series of Handbooks of Commerce and Finance planned to meet the need of a simple and graphic presentation of the fundamental principles of commerce and finance. The first three volumes, dealing respectively with "Transport and the Export Trade," "The Import Trade: Mixing Commodities," and "The Use of Graphs in Commerce and Industry," will be ready shortly.

Our Astronomical Column.

THE METEORIC RADIANTS OF JUNE 25–30.—Mr. Denning writes:—The possible occurrence of an abundant meteor shower from Pons-Winnecke's comet will attract a great number of astronomical observers to watch the heavens. The moon will rise late, and, being at her last quarter, will not offer any serious impediment to observation.

There are a considerable number of radiant points visible at this period of the year, though the usual rate of apparition is not nearly so great as in the two following months of July and August.

The great shower of Perseids probably begins at the end of June, and the radiant is then situated at about 0°+36°. As it may prove useful for reference, a list of the principal radiant points observed in past years between June 25 and 30 is appended:—

0°+36°	238°+47°	282°−12°	314°+61°
24+42	245+64	282−24	320+11
30+36	260−24	291+52	320+21
43+37	261−12	291+60	334+57
48+44	261+ 4	294+40	334+28
161+58	263+63	304+23	342+39
193+57	270+47	305−12	354+39
213+53	270+30	314+47	354+77

REPORT OF THE KODAIKANAL OBSERVATORY FOR 1920.—It has already been mentioned in this column that direct comparisons of the solar lines with those of cyanogen and iron gave results fairly near those predicted by Einstein, but since the shifts were different for different substances, and also not proportional to the wave-length, they could not be wholly due to a gravitational effect. Tests made on the Venus spectrum gave further evidence of the shift being in part an "earth effect." A considerable improvement has been effected in the Venus spectra by using "Barnet Ultra Rapid" plates hypersensitised with ammonia; these enabled a very narrow slit to be used. When the terminator was placed normal to the slit, no evidence was obtained of an inclination of the spectral lines due to rotation of the planet. A recent letter from the director states that further photographs will be taken to test the rotation in sixty-eight hours about a highly inclined axis that was recently provisionally announced by Prof. W. H. Pickering. It was found that change of altitude produced no change in the wave-lengths in the Venus spectra, the range of altitude extending from below 20° to above 40°.

The use of an ultra-violet spectrograph with a quartz collimating lens demonstrated the solar origin of the ammonia band in the solar spectrum at λ3360, since the rotation shift between the east and west limbs was shown.

The spot activity, as indicated by the number of groups, diminished 40 per cent. in 1920 as compared with 1919. It is noteworthy that the spot group associated with the great magnetic storm of 1920 March 22–23 returned five times (1920 January to May), there being a magnetic storm on each occasion.

Unlike the spots, there was an increase in both prominences and hydrogen absorption markings as compared with 1919. A great eruptive prominence seen in 1920 December 31 strongly resembled that seen in the eclipse of 1919 May. A continuous series of spectrograms was secured, which showed the prominence matter ascending rapidly and fading away at a height of 16′ above the limb.

POPULAR ASTRONOMY IN SWEDEN.—We have already directed attention to the *Popular Astronomisk Tidskrift;* Häfte 1 o. 2, 1921, is another number full of interest. We may refer specially to an illustrated article by V. Carlheim-Gyllensköld on Tycho Brahe and his observatory on the island of Hven; many photographs of the present aspect of the latter are given, showing that it is still possible to trace out the outlines of the foundations of all the buildings and instruments. A portrait of Tycho Brahe and a photograph of the house where he was born are also reproduced, together with many relics unearthed from the ruins.

The latitude of Sweden favours observations of auroræ, which are made systematically at several stations. The auroræ of September 28 and October 17, 1920, are described in detail, with diagrams indicating the exact locations of auroral streamers among the stars.

The Second Royal Society Conversazione.

THE second Royal Society conversazione of this year was held at Burlington House on June 15, when Prof. C. Sherrington received the fellows and guests.

Some of the exhibits had been displayed at the first conversazione and were described in NATURE of May 19, p. 377; others were new, and the following brief descriptions have been taken from the descriptive catalogue.

Sir John Dewrance and Prof. E. G. Coker: Apparatus for investigating the action of cutting tools by polarised light. A transparent disc is turned at a slow speed by an electric motor through a worm reduction gear, and the cutting tool of glass or other material is clamped in a slide rest and receives a determinate radial feed from the main drive. The mode of action of various forms of cutting tools is observed in polarised light, and the stress distributions in both work and tool are investigated by this latter means.

Mr. R. N. Chrystal (Forestry Commission): An insect enemy of the Douglas fir recently introduced from America, *Chermes Cooleyi*, Gill. This insect may prove a serious enemy of our two most important exotic conifers, the Douglas fir and the Sitka spruce.

Mr. Percy J. Neate: Recording extensometer for textile yarns, etc. The specimen is secured vertically between an upper grip attached to a spring and a slowly descending lower grip. The movement of the lower grip is therefore the sum of the extensions of spring and specimen. This movement is halved and transmitted to a platen travelling downwards at an angle of 60° to the vertical. The spring is designed for a scale of 12 oz. = 3 in. ordinate, but is calibrated to extend $3 \times 2/\sqrt{3}$ in. at that load. The combined effect is to eliminate spring extension from the abscissæ and excess spring extension from the ordinate.

Mr. William Barlow: The methods of chemical graphic formulæ modified so as to interpret crystal structure by means of models. Certain partitionings of space into similar cells embody the conception that stable equilibrium of a crystal indicates the presence of similarly situated centres of repulsion. In the case of the diamond when regular dodecahedral cells are employed and four cells, forming a tetrahedral group, are allotted to each atom, the symmetry traced by the Braggs is presented by the group centres. The case of benzene is found to be met if, while four cells stand for each carbon atom, one is representative of each hydrogen atom. Further investigation has revealed the general principle that the allotment of the cells among the atoms follows the fundamental valencies; thus a monovalent atom requires one cell, a divalent two, a trivalent three, and a carbon atom four. In a large number of cases an appropriate partitioning into similar unit-cells when fully allotted on the principle just stated yields assemblages of cells almost identical in symmetry and relative dimensions with the corresponding crystals.

Sir Henry Howorth: A Dutch house interior. A *tour de force* in perspective, painted by De Hooge or his pupil Hoogestratten, whose name occurs on a representation of a letter on the table, probably for exhibition at a Kermeez or Dutch fair. The late Lord Kelvin and others were puzzled to know how it was executed, since the picture is painted on three planes; since a different view is seen when looked at from the holes at either end and there are no lenses in the holes, it would be interesting to know how the artist accommodated his drawing.

Prof. R. C. Punnett: Hen-feathered cocks. In some breeds of poultry the cocks are feathered like the hen, lacking the characteristic hackles and sickles of normal cocks. Experiments have shown that the assumption of henny feathering by the cock is due to a factor which behaves as a Mendelian dominant. Castration of such birds leads to the assumption of normal male plumage. Experiments by Goodale in America and Pézard in France have shown that the castrated hen also develops cock feathering. It seems probable that hens and henny cocks alike contain a factor which inhibits the development of the normal cock plumage.

Royal Observatory, Greenwich: Astronomical photographs. (1) Four Franklin Adams chart plates in frame. (2) Solar eclipse, 1919, May 29, showing prominence and corona. (3) Solar eclipse, 1919, May 29, showing surrounding stars. (4) Solar eclipse, 1921, April 8. (5) Sun-spots, 1921, May 13.

The Rev. A. L. Cortie: Astronomical photographs and drawings from Stonyhurst College Observatory. (1) Bright-line spectra of Nova Cygni III., 1920. August 29 and 30 and September 6. The great intensity of $H\alpha$ is shown on the plate of August 30. (2) The genesis of the great sun-spot group of 1920, March 22–27. The drawings were the last made by the late Br. Wm. McKeon, S.J. They were reproduced by him from drawings made at the telescope, and show the development of the disturbance from 1919, December 27.

Dr. William Wilson: A new form of astronomical model designed for educational purposes. The model, while demonstrating the more familiar motions of the sun, earth, and moon and the various phenomena resulting therefrom, reproduces, in addition, the retrograde motion of the moon's orbital nodes (with its synodic revolution of 346 days) and the forward motion of the moon's apsides (with its synodic revolution of 412 days), and is thus capable of affording a demonstration of the Chaldean "Saros" or eclipse cycle of 18 years and 11 days, with its 41 solar and 29 lunar eclipses, the dates on which these eclipses will occur, and the further differentiation of them into total and partial in the case of the moon, and total, partial, and annular in the case of the sun.

The Meteorological Office: Apparatus for recording atmospheric pollution. Dr. Owens's automatic air filter is an instrument which at the end of every fifteen minutes automatically draws two litres of air through a piece of fine blotting-paper. The darkness of the circle of deposit left on the paper gives an estimate of the amount of suspended matter in the air. Records are shown illustrating the reduction in the amount during the coal strike and the relative importance of domestic fires and factories. The amount of suspended matter is found to be closely connected with the vertical electric force. The reduction in the latter at the end of a fog is illustrated by a record taken at Kew.

The National Physical Laboratory: (1) Paterson-Walsh electrical height-finder. Designed during the war for measuring the height of enemy aircraft, it depends on the Bennett-Pleydell "roof" principle of height measurement. The action of the electrical height-finder is, by means of a sliding bar situated in each sighting plane and passing over a horizontal uniform resistance, to obtain at each station a potential proportional to the contangent of the angle of elevation at that station. These two potentials, combined in series by cables connecting the two stations, and operating across a resistance proportional to B, give a current inversely proportional to the height, and thus a milliammeter may, by making it with an inverse height-scale, be made to give a continuous indication of the height of any object on which the two planes are constantly sighted. (2) Photomicro-

graphic transparencies (Metallurgical Department). Photomicrographs, shown as enlarged transparencies, illustrating recent work relating to the constitution of various alloys of aluminium. They show typical structures found in the alloys of aluminium with magnesium, copper, silicon, iron, and zinc when treated in various ways. Some illustrate particularly the method of determining the temperature at which the alloys become completely solid by quenching small specimens from various temperatures. The presence of liquid at the moment of quenching makes itself felt by a characteristic fine micro-structure.

The Cambridge and Paul Instrument Co., Ltd.: Darwin-Hill mirror position-finder. This instrument enables the position of an object moving in the air to be accurately recorded in terms of three rectangular co-ordinates. Two horizontal mirrors ruled in squares are placed one at each end of a common base line, the rulings being parallel and perpendicular to the base line. The object is observed through a fixed, but adjustable, aperture sight, and the position of the image in each mirror is marked on the glass surface either continuously or at simultaneous times controlled by telephone or signal. Each mirror gives two co-ordinates for any position of the image, from which the three co-ordinates of the object can be calculated for successive positions. These instruments have been used for the observation of high-angle gun-fire for the preparation of range tables, for checking anti-aircraft gun-fire, and for recording the flight of experimental aircraft, pilot-balloons, etc.

The Science Museum: Gravity torsion balance. This instrument was designed by Baron R. Eötvös, professor of physics at the University of Budapest, in order to determine the variation of gravity over comparatively short distances, and to make experimental investigations on the form of the earth. The instrument has also been used in Hungary for the location of mineral deposits when the density of the mineral differed considerably from that of the surrounding strata.

Radiological Branch, Research Department, Royal Arsenal, Woolwich: Pinhole photographs of the Coolidge radiator tube and photographs illustrating protection in the X-ray examination of materials. (1) Pinhole photographs illustrating the change in shape of the focal spot with current change. (2) Photographs illustrating the various parts of the target of the above tube which emit X-rays under varying conditions. (3) Photographs illustrating X-ray protection when radiographing large metal objects. (4) Photographs illustrating portable set designed and made in the Research Department, Woolwich, with complete protection, for visual examination of materials.

Instrument Department, Air Ministry: (1) Mercury barometer for use on airships. (2) Differential thermometer for airships. (3) Twin-pointer revolution indicator. (4) Gyroscopic turning indicator. (5) Aneroid altimeter with computer dial. (6) Permeameter. (7) Liquid oxygen vaporiser

Mr. A. Leslie Armstrong: Engravings upon flint-crust discovered at Grimes Graves, Norfolk, together with flint implements, upon an ancient living level 3 ft. beneath the present surface. The most important engraving is a wonderfully likelife drawing of a stag, or perhaps an elk, evidently disturbed whilst browsing. One foreleg is raised, the others are buried in herbage. The head is held erect and stalks of grass are shown hanging from its mouth. A second engraved piece has a well-drawn animal's head upon it, apparently that of a hind. Others bear lines and irregular forms on them. All were discovered in September last by the exhibitor upon an ancient living level upon glacial sand 3 ft. beneath the present surface, associated with flint implements of Mousterian type, bone tools, and pottery.

British Museum (Natural History): Fading of museum specimens exposed to light (Sir Sidney Harmer). The object of the experiments was to test the efficacy of "antifade" glasses in protecting specimens from fading. The conclusions reached are (1) that specimens kept in the dark do not fade when subjected to a considerable rise of temperature; (2) that objects exposed to direct sunlight are bleached even if protected by "antifade" glass; (3) that the injurious action of either diffused daylight or strong electric light is far less than that of direct sunlight; and (4) that "antifade" glasses may have some slight advantage in protecting specimens from the bleaching effect of diffused daylight or of electric light.

Department of Geology, British Museum (Natural History): An ancient human skull from the Transvaal (Mr. W. P. Pycraft). Towards the end of 1913 a human skull-cap and temporal bone, and a few other skeleton fragments, apparently of considerable antiquity, were found at Boskop, in the Potchefstroom district of the Transvaal. The skull-cap is remarkable for its great length and parietal width—length 205 mm., breadth 150 mm.—while the forehead is narrow. The skull is dolichocephalic and tapeinocephalic. The auricular height could scarcely have exceeded 125 mm., and from this it may be assumed that the cranial capacity did not exceed 1700 c.c. The precise affinities and geological age of this skull are matters now under investigation.

Department of Zoology and Comparative Anatomy, University College: Cytological preparations.—(*a*) Golgi apparatus; (*b*) polar body, Ornithorhynchus egg; and (*c*) *Anello cromatico*, Dytiscus (Dr. Gatenby).

Dr. C. T. Trechmann: Shell of the recent Pleurotomaria (*P. Adansoniana*) dredged off Barbados, West Indies, in 60 fathoms of water Pleurotomaria is a "living fossil"; possibly only about five specimens of this species are known. Other species occur off Japan.

Zoological Laboratory, Imperial College of Science, South Kensington, S.W.: Effect of pineal gland administration on amphibian melanophores (Dr. L. T. Hogben). Administration of fresh gland or pineal extract causes contraction of the melanophores. This effect first appears after a previous treatment of ten days with tri-weekly administration, and follows each subsequent treatment lasting for six hours and attaining maximum contraction in half an hour. Tadpoles become exceedingly pale and quite transparent in the head region when under treatment while the effect lasts.

The South-Eastern Union of Scientific Societies.

THE twenty-sixth annual congress of the South-Eastern Union of Scientific Societies was held at Reading on June 8–11, under the presidency of Prof. E. B. Poulton, who, in his presidential address on "The Inspiration of the Unknown," showed that entomology was a world in which many workers were still needed, and that great blanks in knowledge still required filling up. Dr. Dukinfield Scott contributed a paper on "The Earliest Land Flora," and brought under notice the work of Kidston and Lang on the Lower Devonian flora, and illustrated by the lantern the structure of Psilophyton, a genus founded by Dawson and only now at last coming to be generally accepted by palæobotanists. Miss G. Lister

read a paper on "Conifers in English Gardens," and illustrated her remarks by a large number of specimens; great interest was shown by the delegates in this popular exposition of native and introduced conifers. A third botanical paper was by Prof. G. S. Boulger on "The Origin of the English Flora."

The Silchester rooms at the Reading Museum were crowded when Mr. Mill Stephenson gave a demonstration on the Silchester discoveries. The thoroughness with which the excavations were carried out revealed a complete picture of Romano-British life, including temple, baths, silver refinery, amphitheatre, hypocaust, dwellings, latrines, and all that went to make up a centre of commercial life of the period. The cemetery remains unexcavated. The city is now again buried, the walls alone showing, whilst outside there still remain the earthworks of an earlier period still, when Neolithic Britons planned a camp of wider dimensions. Roman ornaments in bronze called for special notice, these being beautifully executed. A carpenter's plane was remarkable in that it was of metal, and included screws for adjusting the blade. A visit to Silchester enabled many members to pick up fragments of Roman brick and Gaulish ware. Regret that no portions of the buildings or the foundations had been left uncovered was expressed. It is inconceivable that our British Pompeii was again buried out of sight almost as soon as it was excavated.

A visit to Windsor enabled members to see St. George's Chapel and the King's library and to ascend the Round Tower. Papers were read by the Hon. J. W. Fortescue and Dr. A. V. Baillie. A popular lecture was given by Mr. H. E. Peake on "Racial Types in South-East England," and this gave rise to an animated discussion as to whether all the portions of the Eoanthropus skull had been properly fitted as parts of one and the same skull. It was pointed out that portions of at least three individuals had been found. A paper by Prof. John Percival on "Species and Races of Wheat" was of valuable economic interest. Growing plants of *Aegilops ovata* were exhibited and the part it has taken in the evolution of modern wheat expounded. Specimens of various wheats were shown, including the hard, snow-resisting *Triticum spelta*.

The afternoon excursions included a visit to the relics of Reading Abbey, of which the Chapter House is the most important and extensive. The hall measured 79 ft. by 42 ft. One of the tablets on the wall commemorates that ancient musical composition, "Sumer is icumen in," which is stated to have been written down at the abbey about A.D. 1240. A visit to the economic garden of Dr. J. B. Hurry showed the great care here exercised to make the garden of an educational nature. The medicinal plants growing numbered twenty-five, food plants twenty, fabric plants eleven, and dye plants twenty; whilst the herbal garden contained a very large number of useful plants which were grown extensively in the Middle Ages, and alluded to by Chaucer, Spenser, Shakespeare, and others. In the museum attached were many commercial derivatives from the plants. A fine fabric made from the common nettle was noticeable. Archæologists paid an afternoon visit to the quaint Upton Court, with its many-gabled roofs and its hidden priest-holes, and to Padworth and Aldermaston churches, when Mr. C. E. Keyser acted as guide. The University College was also visited, after which the party proceeded to the Experimental Gardens at Shinfield.

It is worthy of note that Reading Museum possesses a copy in needlework of the famous Bayeux tapestry, executed by the Leek Needlework Society. We remember that when we last saw the original at Bayeux it had suffered mutilation by a relic-hunter, and the three-cornered piece which had been snipped out, having come into possession of the South Kensington Museum, had been returned to Bayeux, but instead of being replaced in position it was mounted separately on a block. Perhaps it has since taken its proper place in the tapestry and the modern piece which had been worked in been removed.

An important portion of the business of the congress was the complete revision of the rules, which after discussion were passed as presented by the council.

The Orientation of the Dead.

AT a meeting of the Royal Anthropological Institute, held on May 31, Prof. H. J. Rose read a paper on "Celestial and Terrestrial Orientation of the Dead." Two forms of orientation were distinguished and illustrated by examples; namely, graves orientated (*a*) on a point in the heavens, as the east; (*b*) on a point on the surface of the earth, *e.g.*, Mecca. The former Prof. Rose called celestial, the latter terrestrial, orientation. The deciding factor was normally the point towards which the face of the buried corpse turned. This point was often the former habitat, whether real or supposed, of the dead man's people.

The author compared the custom, common among many peoples, of burying in or near the hut, or facing towards the supposed home of the man's spirit at or before birth. This was combined with a belief in reincarnation: the ghost, feared and avoided as such, was welcomed when it became a baby, born of a woman of its own clan or tribe; but as the rebirth of some persons, *e.g.* notorious criminals, was not desired, means were taken to place their bodies in such a position that the ghost would get lost. Thus only the desirable people were buried in the normal place or with the normal orientation towards the dwelling-place of their potential mothers or towards Hades, whence in many cases the souls of the new-born come.

Belief in reincarnation, however, need not of necessity lead to the practice of orientation.

Celestial orientation was not always possible in low grades of culture which might have no knowledge of any such thing as cardinal points. Where celestial orientation existed such knowledge could not be assumed without further evidence. It might indicate (*a*) the departure of the dead to a land of darkness, marked by the position of the setting sun; (*b*) the departure to a land of light, marked by sunrise. Moreover, as some were too bad to be wanted back on earth, some also (*e.g.*, important chiefs) were too exalted ever to become babies again. Hence to find a cemetery containing a number of bodies most of which face to one quarter while a considerable number face to another rather proved than disproved deliberate orientation. This applies, for example, to the burial-ground of Megara Hyblæa.

Orientation E.–W. was frequently accompanied by orientation N.–S. Houses were frequently constructed so as to facilitate observation of the position of the sun. If this was done, it was a matter of indifference whether the house ran N.–S. or E.–W. The grave was regarded as the house of the dead.

Another possibility was that the grave, as a sleeping place, was so arranged that the rising sun would warm and vivify the sleeper. This applies only to the E.–W. position.

The idea of the journey of souls to a place on earth, but far distant, may often be distinguished from

celestial orientations (*a*) by the fact that they tend to converge, not to diverge, in direction; (*b*) by the absence of graves at right angles to the prevailing direction.

They may also be orientated by being placed along a road of spirits. There were three main classes of non-orientated burials, those with (*a*) an absence of any intelligible arrangement whatsoever, as in the British round barrows, (*b*) a funeral feast arrangement, as among the Siculi and some Amerindians, (*c*) a "Sociocentric" arrangement, as among the Wotjobaluk, Omaha, Ponka, etc.

In conclusion, Prof. Rose suggested that if his deductions were sound, they afforded, *inter alia*, a new test of race.

In the discussion which followed the reading of the paper Dr. Rivers, the president, pointed out that Prof. Rose, in coupling reincarnation and terrestrial orientation, had suggested an entirely new connection. In Melanesia orientation was usually terrestrial. There was, however, a form of orientation which, while being celestial, had no connection with the cardinal points. It was in the direction of a home of the dead in the sky, which he connected with the Melanesian variant of upright burial and the custom of burying the dead in the sea with weights attached to their legs. Dr. Rivers suggested, further, that our own practice of laying the corpse on its back may be connected with the home of the dead in the sky. Prof. Elliot Smith referred to the custom of the proto-dynastic Egyptians who buried their dead with the head to the south, while in the second and third dynasties they were buried with the head to the north, in each case towards the country of origin. Mr. H. Peake pointed out that the terrestrial orientation would tend to become celestial as a people in the course of its wanderings lost the memory of the direction of its original point of departure.

The National Academy of Sciences, U.S.A.

THE annual meeting of the National Academy of Sciences was held at the Smithsonian Institution on April 25–27. Unusual interest was taken in the meetings owing to the presence of his Serene Highness Albert I., Prince of Monaco, Prof. and Mrs. Albert Einstein, and Dr. Frank Adams, of Montreal, a foreign associate. In accordance with a precedent of long standing, President Harding received the academy.

On Monday evening, April 25, the Prince of Monaco gave an address, illustrated by moving pictures, on his researches in oceanography, for which the Agassiz medal, founded by the late Sir John Murray, was awarded to him by the academy in 1918. After the address the Prince graciously received the members of the audience at a reception held in the National Gallery of Art.

On Tuesday the president, Dr. C. D. Walcott, extended a welcome to Prof. Albert Einstein on behalf of the academy, to which Prof. Einstein briefly responded, expressing his sense of pleasure at being present at the meeting of the academy and receiving its welcome.

On Tuesday evening, at the annual banquet, the presentation of the academy's medals was made. The Mary Clark Thompson medal, for eminence in researches in palæontology and geology, was awarded for the first time to Dr. Walcott for his classic studies in Cambrian palæontology. The Agassiz medal for 1918 was presented to the Prince of Monaco. The Agassiz medal for 1921 was presented to Admiral Sigsbee for his investigations, including deep-sea soundings and other oceanographic work, mainly in the Gulf of Mexico. The Henry Draper gold medal, for eminence in astronomical physics, was awarded to Prof. P. Zeeman, of Amsterdam, for his discovery of the so-called "Zeeman effect" and for the study of the influence of magnetism upon light. In Prof. Zeeman's absence the medal was communicated through Dr. Hubrecht, secretary of the Netherlands Legation. The Daniel Giraud Elliot medal was awarded to Dr. Robert Ridgway for his studies of the birds of North America, especially part viii. of his "Birds of North and Middle America," which has recently appeared. The Hartley gold medal for eminence in the application of science to the public welfare was awarded to Dr. C. W. Stiles for his work in the investigation and eradication of the hookworm disease in the United States.

At the business meeting on Wednesday, April 27, Dr. Walcott tendered his resignation as president of the academy on account of his desire to lay down something of the burden of administrative work which he has long carried, and in order to be able to devote himself more completely to his studies of palæontology, but at the unanimous desire of the academy he consented to withdraw his resignation for the remaining two years of his term. Dr. George E. Hale resigned the office of foreign secretary on account of ill-health, and Dr. R. A. Millikan was elected to succeed him. Messrs. Hale and Pearl were elected to the council, and the following new members were elected to the academy: Messrs. Frank Michler Chapman, William Leroy Emmet, William Draper Harkins, Ales Hrdlicka, Arthur Edwin Kennelly, William George MacCallum, Dayton Clarence Miller, George Abram Miller, Benjamin Lincoln Robinson, Vesto Melvin Slipher, Lewis Buckley Stillwell, Donald Dexter Van Slyke, Thomas Wayland Vaughan, Henry Stephens Washington, and Robert Sessions Woodworth.

Numerous papers were presented at the scientific sessions. The principal feature was the address of Dr. W. S. Adams, of Mount Wilson Solar Observatory, on his spectrum researches on the motions in the line of sight and the absolute magnitudes of nearly 2000 stars. Dr. Adams pointed out the excellent confirmation of Russell's theory of giant and dwarf stars, and discussed the bearing of the observations on the dependence of stellar velocities upon spectral type and absolute magnitude. He also treated several other questions which are no longer insoluble now that, for the first time, the positions, directions, and velocities in space of such a large and homogeneous mass of stars have become known.

Dr. C. D. Walcott gave a profusely illustrated paper in which he directed attention to the great detail in the structure of the trilobite which he has found by the application of a new photographic process.

Dr. H. F. Osborn, of the American Museum of Natural History, New York, traced the evolution and geographical distribution of the Proboscidea. The two main groups of the mastodons and true elephants were followed, by the aid of skeletal photographs, restorations, and maps, from their original homes in northern Africa and Central Asia in the Eocene through their migrations over Europe and Asia to North and South America by way of Bering Strait.

Another paper of the same general character was given by Dr. J. C. Merriam, president of the Carnegie Institution, on his twenty years of study of the evolution and geographical distribution of the bear family.

Dr. L. R. Jones, of the University of Wisconsin, showed the pathological influence of temperature, and

the relation of it to the adaptability of certain soils and climates to the growth of the principal food crops.

Dr. Simon Flexner communicated the results of experimental epidemics produced in colonies of mice, in which it was shown that the mortality is enhanced by the introduction of fresh subjects after the epidemic has nearly run its course, the recurrence among the original colony seeming to be promoted by the disease of the new individuals.

Novel experiments on the skin temperature of pachyderms, reported by Dr. F. G. Benedict, embraced measurements of the temperatures of the elephant, rhinoceros, and hippopotamus at the New York Zoological Gardens. The difference between the results for these hairless animals and the results for man seem to depend largely on the great thickness of the skin, with accompanying control by outside as contrasted with interior temperature conditions.

A short popular account was given by Dr. C. G. Abbot of his experiments with solar cooking apparatus on Mount Wilson. The application of the solar heat is indirect through an oil circulatory apparatus, including a reservoir in which are inserted the ovens. All kinds of domestic cooking, except frying, and the preserving of fruits and vegetables were carried on. A jar of preserved pears prepared in the solar cooker was exhibited.

In a paper by J. R. Carson and J. J. Gilbert on transmission characteristics of the submarine cable, further employment was made of the extraordinary opportunity enjoyed by physicists during the war owing to the Government control of the Alaskan cable. A valuable paper had been given on the characteristics of this cable by signal corps officers at the academy meeting of 1920. Further applications of the results were now given.

A New Treatment of Sleeping Sickness.

AT a meeting of the Royal Society of Tropical Medicine and Hygiene held on May 20, Dr. Claude H. Marshall, senior medical officer of the Uganda Protectorate, read a paper on a new treatment of trypanosomiasis (sleeping sickness) which had been originated by Dr. S. M. Vassallo, of the Uganda Medical Service, and himself. Remedies injected into the circulation, though they may sterilise the blood, probably do not destroy the parasites in the central nervous system, since the trypanosomes produce thickening and occlusion of the choroid plexus at an early stage of the disease, and thus prevent the passage of drugs from the circulation into the spinal fluid. In 1918, therefore, in a well-marked case of sleeping sickness, an intravenous injection of neokharsivan was made, and three hours afterwards 2 oz. of the patient's blood was withdrawn; 20 minims of the serum was then injected into the spinal canal, and no further treatment was given; twenty-seven months afterwards the patient was quite well, and his blood free from parasites. Of thirty cases similarly treated a large majority were quite well at periods varying from six and a half to twenty-seven months afterwards. The results are supposed to be due only in part to the drug contained in the serum; it is held that an antibody, trypanolysin, is formed in the blood of an infected patient, but that this cannot in ordinary circumstances reach the parasites in the central nervous system. Acting on this view, Dr. Vassallo is now treating cases along similar lines, but without previous intravenous injection of the drug. Later speakers emphasised the value of the work of Dr. Marshall and his colleague; but it was pointed out that it was early as yet to claim that the cases were permanently cured.

University and Educational Intelligence.

CAMBRIDGE.—The Frank Smart prizes for botany and zoology have been awarded to A. J. Smith, Downing College, and G. S. Carter, Gonville and Caius College, respectively.

GLASGOW.—Sir John H. Biles has intimated his intention to retire in September next from the John Elder chair of naval architecture and marine engineering, which he has held since 1891. Prof. Biles has served in many capacities under the Admiralty and the Board of Trade, and is Consulting Naval Architect to the India Office. He received the thanks of the India Council for his services in designing and constructing river craft for the Mesopotamia Expeditionary Force during the war.

The late Mr. William J. Chrystal, chemical manufacturer, of Shawfield Works, Rutherglen, has bequeathed 10,000*l.* to the University, to be applied as the Senate may determine; and also 10,000*l.* to the Roval Technical College, for endowment.

OXFORD.—Dr. E. Mallam, of Magdalen College, has been appointed Litchfield lecturer in medicine for two years as from October 5 next.

Final approval has been given in Convocation to the statute constituting the Delegacy for the Society of Oxford Home Students, and to the decree authorising the loan of 19,000*l.* from the special reserve fund for the completion of the Dyson Perrins Laboratory.

ST. ANDREWS.—Dr. R. Robinson, director of research in the British Dyestuffs Corporation, Huddersfield, has been appointed professor of chemistry and director of the chemical research laboratory in succession to Prof. Irvine, now Principal of the University.

THE award of the William Gibson research scholarship for medical women (the second since its foundation) has been made by the council of the Royal Society of Medicine to Miss Gertrude M. A. Herzfeld, of Edinburgh.

THE *Chemical Age* for June 18 announces that Mr. K. C. Browning, who for many years was Government analyst in Ceylon, has been appointed professor of chemistry and metallurgy at the Artillery College (formerly the Royal Ordnance College), Woolwich.

AT the meeting of Leeds University Court, held on June 15, the sixteenth annual report for the year 1919–20 was adopted. The vice-chancellor, Sir Michael Sadler, addressed the court, and stated that the most urgent question before the university was one of finance. The cost of maintenance was almost double that of 1918, and the balance sheet for the current year would show a deficit of 14,000*l.* The present income was about 140,000*l.*, of which 32·7 per cent. came from Government grants, 16·4 per cent. from local education authorities, 14·8 per cent. from endowments, etc., and 36·1 per cent. from students' fees. At present the average cost per student is 75*l.* per annum, and the average fee paid is 27*l.* It has therefore been decided to adjust the fees to meet the difference between the total cost of the education provided and the funds derived from all other sources. Under present conditions this means an increase of 10*l.* per annum in the tuition fees and a small increase in examination fees. The report contains some account of the work in hand in the various departments, and concludes with a list of donations, etc., from which it appears that during the past year the university has received more than half a million sterling in donations, including eight gifts of 10,000*l.* and over, and one of 77,250*l.*, in addition to their annual subscription of 4000*l.* from the Clothworkers' Company of London.

Calendar of Scientific Pioneers.

June 23, 1881. Matthias Jakob Schleiden died.—At first an advocate at Hamburg, Schleiden afterwards held the chairs of botany at Jena and Dorpat. He did much to establish the cell theory, while among his important writings was his "Principles of Scientific Botany."

June 23, 1891. Wilhelm Eduard Weber died.—Professor of physics in the University of Göttingen, Weber was associated with Gauss in some of his investigations, and did valuable work on the definition and determination of electrical units.

June 23, 1896. Sir Joseph Prestwich died.—While in business as a London wine merchant, Prestwich studied the geology of Hampshire and the London basin, the coal supply of England, and the antiquity of man. At the age of sixty-two he succeeded Phillips as professor of geology at Oxford.

June 25, 1868. Carlo Matteucci died.—The recipient in 1844 of the Copley medal for his electrical researches, Matteucci was professor of physics, first at Bologna, and then at Ravenna and Pisa. For some years he was connected with the Italian telegraphs.

June 26, 1793. Gilbert White died.—Educated at Oxford, and for a time senior proctor, White passed most of his life at Selborne. His well-known "Natural History and Antiquities of Selborne" was published in 1789.

June 26, 1831. Sophie Germain died.—A versatile and learned woman, Sophie Germain was distinguished for her mathematical writings on elastic surfaces.

June 26, 1883. Sir Edward Sabine died.—An officer in the Royal Artillery, Sabine made valuable pendulum and magnetical investigations which gave an impulse to the systematic study of terrestrial magnetism. From 1861 to 1871 he was president of the Royal Society.

June 27, 1829. James Smithson died.—Owing to circumstances of birth, Smithson was educated at Oxford under an assumed name. His knowledge of chemistry and mineralogy led to his being admitted as a fellow of the Royal Society in 1787. Most of his life was spent on the Continent, associating and corresponding with men of science. He died at Genoa, leaving his fortune of more than 100,000*l.* to the United States, the Government of which founded the famous Smithsonian Institution.

June 27, 1876. Christian Gottfried Ehrenberg died.—After travelling through East Russia with Humboldt, Ehrenberg became a professor at Berlin, and in 1842 was made secretary to the Berlin Academy of Sciences. He was the first to show that certain rocks consisted of minute forms of animals or plants. His "Mikrogeologie" was published in 1854.

June 27, 1892. Carl Schorlemmer died.—A student of Bunsen's, Schorlemmer in 1858 came to England as assistant to Roscoe, and in 1874 was appointed professor of organic chemistry at Manchester.

June 28, 1897. Paul Schutzenberger died.—The successor of Balard at the Collège de France, Schutzenberger made important researches on colouring matters, the constitution of alkaloids, and on platinum compounds.

June 29, 1895. Thomas Henry Huxley died.—As a naval surgeon Huxley cruised in H.M.S. *Rattlesnake*, and sent home important papers on the Hydrozoa. From 1854 to 1885 he was professor of natural history at the School of Mines. His scientific work embraced vertebrate and invertebrate morphology, comparative anatomy, histology, and palæontology. His lucid essays and crusade for freedom of thought attracted widespread attention, and as "a man and a citizen" he undertook much public work. E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 16.—Prof. C. S. Sherrington, president, in the chair.—H. B. **Dixon**, Dr. C. **Campbell**, and Dr. A. **Parker**: The velocity of sound in gases at high temperatures, and the ratio of the specific heats.—Prof. J. R. **Partington**: The ratio of the specific heats of air and of carbon dioxide. The ratio of the specific heats, $\gamma = c_{-p}/c_{-v}$, has been determined by the method of adiabatic expansion for the gases air and carbon dioxide. The gas was contained in a 120-litre vessel, and the temperature change immediately after expansion followed by a platinum thermometer, with compensating leads of wire 0·001 mm. diameter, the resistance of which was observed by an Einthoven string galvanometer of 0·01 seconds period. The fundamental temperature measurements were made by a mercury thermometer. The results were calculated by the characteristic equation of D. Berthelot, so that deviations from the ideal gaseous state were allowed for. The final results, accurate to 1 part in 1000, are: γ for air at 17° C. = 1·4034; γ for carbon dioxide at 17° C. = 1·3022, whence c_{-p} for air at 17° C. = 0·2387 cal. and c_{-p} for carbon dioxide at 17° C. = 0·1996 cal. All the values refer to atmospheric pressure.—Dr. A. B. **Wood** and Dr. F. B. **Young**: (1) "Light-body" hydrophones and the directional properties of microphones. A light prolate ellipsoid possesses directional properties by virtue of its shape. Quantitative results obtained agree with calculated values supplied by Prof. Lamb. Owing to the pronounced intrinsic directional properties of the microphone, a spherical "light-body" hydrophone is practically equal in directional efficiency to one of ellipsoidal form. "Light-body" hydrophones are of value as experimental exploring instruments. (2) The acoustic disturbances produced by small bodies in plane waves transmitted through water, with special reference to the single-plate direction finder. Sound distribution was explored round a number of discs immersed at a distance from a small submerged source of sound. By means of a pair of miniature hydrophones—one bi-directional, the other non-directional—it was possible to chart (1) direction of oscillation of the water particles; (2) relative amplitude of the movements; and (3) relative amplitudes of the pressure oscillations. The charts obtained fall broadly into two classes, according as the discs are solid or contain air-filled cavities, very minute air-filled spaces giving marked effects. The behaviour of a typical baffle-plate is investigated, but no satisfactory theory of the baffle is offered.—M. A. **Giblett**: Some problems connected with evaporation from large expanses of water. The problems of distribution and amount of water-vapour present are considered for a current of air of uniform speed moving over a water-surface of uniform temperature. Near the surface is a thin layer of air, through which water-vapour diffuses slowly by molecular processes, but above this is a rapid transition to a turbulent *régime*, where diffusion becomes much more rapid. At and near the water-surface the problem is treated as one of eddy diffusion. Formulæ are obtained for humidity at any point of the air-current, and for rate of evaporation from stretches of water extending any distance downwind. The distribution of water-vapour is obtained for some typical cases, and an estimate made of the rate of evaporation from long stretches of water under various conditions of wind, water-surface, temperature, and turbulence. The effects which each of these elements exerts, when varied within their natural range, are examined. The results emphasise the control exercised by atmospheric turbulence over evapora-

tion from large areas.—F. C. **Toy**: The photographic efficiency of heterogeneous light. Two possible laws of action are discussed:—(1) All radiations composing the heterogeneous beam may act simultaneously but independently; and (2) all radiations may act simultaneously but not independently. The possibility of testing the laws depends on the form of law connecting the probability of a single grain of the photographic emulsion being made developable with the intensity of the exciting light. The form of this law proved experimentally by Slade and Higson is considered, and a result is deduced which can be tested by experiment. From the evidence obtained it is concluded that over the spectral range used in the experiments (λ4350 to λ4000) radiations of different frequencies act simply as a total amount even when a difference in quality exists.

Linnean Society, June 2.—Dr. A. Smith Woodward, president, in the chair.—Prof. W. **Garstang**: Haeckel's biogenetic law: A theory of ancestral heredity. Ancestors created, heredity transmitted, and development repeated the order of creation. A generalised recapitulation of the essential grades of ancestral structure was also possible without involving successive adult images in the ontogeny. The morphological test to apply to these theories was whether the stages of ontogeny resemble successive adult organisations more closely than the corresponding formative stages of ancestral ontogeny. This test was invariably in favour of the "persistence theory" of recapitulation and against the theory of accelerated adult incorporations.

Aristotelian Society, June 6.—Prof. Dawes Hicks, vice-president, in the chair.—Dr. Dorothy **Wrinch**: The structure of scientific inquiry. In the earlier stages of empirical generalisations results of a general character are built up and applied by means of the forms of reasoning employed in probability inference, viz. induction and analogy. In the more advanced stage the aim of science is to arrange the general propositions which cover, as particular cases, the phenomena of which we are aware in such a way that the phenomena of the world are deducible from the smallest possible number of assumptions. Logical necessity alone can knit together theories and the experimental results which go with them. It is found that logic consists of relations between sets of properties. The general study of the formal and abstract properties is at the foundation of the great advance in modern science. In particular the process of *true analogy*, whereby the problems of electrostatics, current electricity, thermodynamics, and hydrodynamics are simultaneously solved, is of the utmost importance.

PARIS.

Academy of Sciences, May 30.—M. Georges Lemoine in the chair.—A. **Blondel**: The application of distributed statical transformers to the regulation of high-voltage mains.—B. **Jekhowsky**: Bessel's functions with two variables.—E. **Kogbetliantz**: The developments of Jacobi.—Et. **Delassus**: A consequence of the laws of friction.—J. **Vallot**: Diffuse radiation at Mont Blanc Observatory compared with that at lower altitudes. The stations chosen were at the altitudes 50, 1100, 2500, 4250, and 4350 metres above the sea. A table is given showing mean values for the observations on several exceptionally fine days. The diffuse radiation diminishes at first up to an altitude of 2500 metres, and then at the top of Mont Blanc increases suddenly to nearly double. This is explained by the intense radiation of the snow.—A. **Schaumasse**: Observations of the Dubiago comet (1921*c*) made with the bent equatorial at the Observatory of Nice. Positions given for May 24 and 25. The comet was of the 11·5 magnitude, and showed a slight central condensation.—G. **Bruhat** and Mlle. M. **Hanot**: The Lippich black fringe and the precision of polarimetric measurements. From calculations and experiments cited it is concluded that even after choosing the best position of the line of separation it is not possible, with Nicol prisms, to measure a rotation of the order of 20° with an error less than one minute. With more intense sources of light, such as the mercury arc, this error can be reduced by one half.—R. **Boulouch**: The problem of achromatism of thick-centred systems.—M. **Rothé**: Radiogoniometry and atmospheric influences. Earlier observations (1914) had shown that in the course of the day Hertzian waves were absorbed by the atmosphere. The present research was an attempt to find out whether, in addition to absorption, the direction of the waves was modified. The deviations observed were of the order of the experimntal error, and consequently no certain conclusion could be drawn as to the cause of the small variations observed.—G. **Déjardin**: The ionisation of argon by slow electrons. An account of the application of the lamp with three electrodes, of the type commonly employed in military wireless telegraphy, to the determination of the ionisation potential of argon. The value found was 15 volts.—A. **Dauvillier**: The L series of uranium and the principle of combination in X-ray spectra.—A. **Cabrier**: An automatic lighting and extinguishing apparatus for street gas lamps. An account of an apparatus which has been in use for eight years, and comparison with a similar apparatus recently described by Paul Bernard and Barbe.—V. **Auger**: Double catalysis of vanadic acid and hydrogen peroxide. Vanadic acid may be reduced to vanadyl sulphate or oxidised to pervanadic acid by hydrogen peroxide in the presence of sulphuric acid, the direction of the change being conditioned by the amount of acid present.—Mlle. **Wolff**: Furfuralcamphor and some of its derivatives. An account of the product of condensation of furfural with camphor and the substances obtained by reduction.—M. **Manolesco**: The action of ethylmagnesium bromide on dibenzylidene *cyclo*hexanone and γ-methyl-*cyclo*hexanone.—G. **Tanret**: The influence of ammonium molybdate on the rotatory power of some sugars. Changes in the rotatory power produced by adding solutions of ammonium molybdate to solutions of xylose, glucose, rhamnose, arabinose, galactose, sorbose, lævulose, and mannose are given. No change was produced in the rotation of saccharose, maltose, trehalose, lactose, melezitose, raffinose, stachyose, inulin, quercite, and inosite. In the cases of the sugars whose rotation was affected, some evidence is adduced of the formation of a compound between the sugar and the molybdate.—F. **Bourion** and Ch. **Courtois**: The formation of Julin's chloride in the preparation of electrolytic chlorine. In certain cases acicular crystals were found in considerable quantities in electrolytic cells. These have been collected, purified, and shown to consist mainly of hexachlorobenzene.—F. **Roman** and P. **de Brun**: The structure of the Alpine chain.—Mlle. G. **Cousin**: The individual variations of *Psiloceras planorbis*.—M. **Flajolet**: The strong magnetic perturbation of May 14–15, 1921. An account of the magnetic disturbance as shown on the recording instruments at the Lyons Observatory. The needle was at times beyond the limits of registration, and all the telegraphic circuits were seriously affected.—G. **Dupont**: Contribution to the study of the acid constituents of the secretion of the maritime pine.

Lævopimaric acid is readily isomerised by heat, acetic, and hydrochloric acids, whilst the dextro-acid is unaffected. With hydrochloric acid the change is effected in two stages, first into α-pimarabietic acid, and this into the stable form, β-pimarabietic acid. The latter acid has been isolated and identified with the pure abietic acid isolated by Schultz.—N. A. **Barbieri**: Anatomical study on the aretinal termination of the optic nerve in the animal series. Results of anatomical analysis are given which, in the author's opinion, prove the complete and reciprocal independence of the retina and the optic nerve in animals. This would suggest the possibility of surgical intervention in the posterior chamber of the eye.—R. **Noel**: Some functional attitudes of the chondriome of the hepatic cell.—L. M. **Bétances**: Cells with eosinophil granulations of histioid origin in the blood circulating in the embryo.—C. **Gorini**: Sudden physiological mutations in lactic ferments by divergent individuals.—M. **Dervieux**: Method of individual diagnosis of the blood and of sperm. A serum is prepared by sensitising a rabbit by injections of human sperm. This serum gives precipitations with human sperm and human blood, and various applications in diagnosis are suggested. By its means it can be determined whether a given sample of blood is that of a man or a woman.—W. **Kopaczewski**: Food anaphylaxy and its therapeutics. In cases where horse flesh has been taken as food, or where infants have been nourished on the milk of the horse, exceptionally grave symptoms have been observed to follow the injection of antidiphtheric serum produced through the horse. It would appear to be probable that the body can be sensitised to a serum by food.—R. **Bayeux**: The use of oxygen mixed with carbon dioxide in subcutaneous injections, as a treatment of mountain sickness and certain toxic dyspnœia.—R. **Sazerac** and C. **Levaditi**: The action of bismuth on syphilis and on the Nagana trypanosome. Potassium tartarobismuthate exerts a marked curative action on experimental syphilis of the rabbit and on the spontaneous spirillosis of the same animal. The curative effects on Nagana trypanosomiasis, although clear, are inferior to the two above mentioned.

Books Received.

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology, vol. iii., No. 9, Insecta. Part i.: Collembola. By Prof. George H. Carpenter. Part ii.: Mallophaga. By James Waterston. Pp. 259–72+i plate. (London: British Museum (Natural History).) 2*s*. 6*d*.

Proceedings of the Cambridge Philosophical Society. Vol. xx., part iii. (Lent Term, 1921.) Pp. 285–397. (Cambridge: At the University Press.) 8*s*. 6*d*. net.

Traité de Dynamique. By Jean d'Alembert. (Les Maîtres de la Pensée scientifique.) No. i. Pp. xl+102. No. ii. Pp. 187. (Paris: Gauthier-Villars et Cie.)

Les Mouvements des Végétaux. Du Réveil et du Sommeil des Plantes. By Rene Dutrochet. (Les Maîtres de la Pensée scientifique.) Pp. viii+121. (Paris: Gauthier-Villars et Cie.)

Contributions to West Australian Botany. Part iii., Additions and Notes to the Flora of Extra-Tropical West Australia. By C. H. Ostenfeld. Pp. 144+xii plates. (København: A. F. Høst and Son.)

The Analysis of Mind. By Bertrand Russell. (Library of Philosophy.) Pp. 310. (London: G. Allen and Unwin, Ltd.; New York: The Macmillan Co.) 16*s*. net.

Mediæval Contributions to Modern Civilisation: A Series of Lectures delivered at King's College, University of London. Edited by Prof. F. J. C. Hearnshaw. Pp. 268. (London and Sydney: G. G. Harrap and Co., Ltd.) 10*s*. 6*d*. net.

A Manual of Seismology. By Dr. Charles Davison. (Cambridge Geological Series.) Pp. xii+256. (Cambridge: At the University Press.) 21*s*. net.

Studies on Arthropoda. By Dr. H. J. Hansen. No. 1. Pp. 80+iv plates. (Copenhagen and London: Gyldendalske Boghandel.)

A History of Persia. By Brig. Gen. Sir Percy Sykes. (In 2 vols.) Second edition. Vol. i. Pp. xxviii+563. Vol. ii. Pp. xx+594. (London: Macmillan and Co., Ltd.) 70*s*. net.

Greenwich Catalogue of Stars for 1910·0. Part 1: Fundamental Stars. Part 2: Stars in the Zone +24·0° to +32·0°. From Observations with the Transit Circle made at the Royal Observatory, Greenwich, 1906–1914, under the Direction of Sir Frank W. Dyson. Pp. xvii+Axvii+A32+Bxxxvii+B249. (London: H.M. Stationery Office.)

Condensed Description of the Manufacture of Beet Sugar. By Dr. Franz Murke. Pp. v+175. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 15*s*. net.

Analyses and Energy Values of Foods. By Dr. R. H. A. Plimmer. Pp. 255. (London: H.M. Stationery Office.) 6*s*. net.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe. Vol. ii.: Calculi to Explosion. Revised and enlarged edition. Pp. viii+717. (London: Longmans, Green and Co.) 60*s*. net.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106. Ergebnisse Aerologischer Beobachtungen. No. 7, 1918. Pp. x+76. No. 110. Oceanographische en Meteorologische Waarnemingen in den Atlantischen Oceaan, December, Januari, Februari, 1870–1914. Pp. ix+217. (Utrecht: Kemink & Zoon.) 7 florins.

Publications of the Astronomical Laboratory at Groningen. No. 30. Pp. vi+110. No. 31. Pp. iii+83+2 plates. (Groningen: Hoitsema Bros.)

Annalen van de Sterrewacht te Leiden. Deel X., Eerste Stuk. Beobachtungen am Meridiankreis in den Jahren 1899–1902 und Deren Bearbeitung. Pp. A112+111. By Dr. E. F. van de Sande Bakhuyzen and Dr. A. Pannekoek. Deel XII., Eerste Stuk. Outlines of a New Mathematical Theory of Jupiter's Satellites. By W. de Sitter. Pp. 53. Deel XII., Tweede Stuk. Analytical and Numerical Theory of the Motions of the Orbital Planes of Jupiter's Satellites. Secular Terms. By Dr. A. J. Leckie. Pp. iii+100. (Leyden.)

Arabian Medicine: Being the Fitzpatrick Lectures delivered at the College of Physicians in November, 1919, and November, 1920. By Prof. Edward G. Browne. Pp. viii+138. (Cambridge: At the University Press.) 12*s*. net.

Prehistory. A Study of Early Cultures in Europe and the Mediterranean Basin. By M. C. Burkitt. Pp. xx+438. (Cambridge: At the University Press.) 35*s*. net.

The Principles of Immunology. By Prof. Howard T. Karsner and Dr. Enrique E. Ecken. Pp. xvii+309+2 plates. (London: J. B. Lippincott Co.) 21*s*. net.

Ministry of Agriculture and Fisheries. Intelligence Department: Plant Pests Branch. Report on the Occurrence of Insect and Fungus Pests on Plants in England and Wales for the Year 1919. (Miscellaneous Publications, No. 33.) Pp. 68. (London.) 1s. 6d. net.

Diary of Societies.

THURSDAY, JUNE 23.

ROYAL SOCIETY, at 4.30.—Dr. E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. VI. Surface Area and Specific Nature of a Catalyst: Two Independent Factors controlling the Resultant Activity.—Sir J. B. Henderson: A Contribution to the Thermodynamical Theory of Explosions, Part I.; and (with Prof. H. R. Hassé) Part II.—S. Butterworth: Eddy Current Losses in Cylindrical Conductors, with Special Applications to the Alternating-current Resistances of Short Coils.—E. S. Bieler: The Currents induced in a Cable by the Passage of a Mass of Magnetic Material over it.—Dr. G. Barlow and Dr. H. B. Keene: The Experimental Analysis of Sound in Air and Water: Some Experiments towards a Sound Spectrum.—Dr. G. Barlow: The Theory of Analysis of an Electric Current by Periodic Interruption.

FRIDAY, JUNE 24.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—S. Butterworth: Capacity and Eddy-current Effects in Inductometers.—Dr. E. Griffiths: New Specific Heat Apparatus.—Prof. A. O. Rankine: Encounters between Non-spherical Gas Molecules.—Dr. C. Chree: An Electro-culture Problem.

MONDAY, JUNE 27.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—K. Fry: The Dental Treatment of Congenital and Other Perforations of the Palate.

TUESDAY, JUNE 28.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—L. H. Dudley Buxton: The Ancient and Modern Inhabitants of Malta.

INSTITUTION OF CIVIL ENGINEERS (Engineering Conference), at 9.—Sir George T. Beilby: Fuel Problems of the Future (James Forrest Lecture).

WEDNESDAY, JUNE 29.

INSTITUTION OF CIVIL ENGINEERS (Engineering Conference), at 10 a.m.—The President: Opening of the Conference and Presentation of the John Fritz Medal to Sir Robert A. Hadfield, Bart.—A. Ross: The Structural Outlines of our Home Railways.—O. G. C. Drury: Tunnel Maintenance.—C. R. S. Kirkpatrick: To what Dimensions should Docks be Constructed to Provide for Future Requirements.—A. R. T. Woods: Ship and Harbour Design and Equipment as affecting the Rapid Loading and Discharging of Cargo Vessels.—H. J. Deane: The Development of Cranage Facilities for Discharging Vessels of the Largest Size.—G. FitzGibbon: Reinforced Concrete for Wharves and Breakwaters.—F. E. Wentworth-Sheilds: The Best Way of Protecting Reinforced Concrete from Marine Deterioration.—L. H. Savile: Reasons for the Deterioration of Reinforced-Concrete Structures above Mean Tide Level.—H. Lupton: Comparison between Reciprocating Pumping Engines and Turbo-driven Centrifugal Pumps.—E. R. Dolby: Exhaust Steam: its Employment for Power, Heating, etc.—J. W. Evans: The Employment of Water Power in the Development of the Mineral Industry.—R. Nelson: Recent Developments in Coal-cleaning Processes.—H. S. Ball: The François Cementation Process.—W. L. Roxburgh: The Necessity for and the Possibility of Development of the Coasting Trade.—E. G. Stewart: The Utilisation of Waste Heat in Gasworks.—Dr. J. S. G. Thomas: Desiderata in the Qualities of Town's Gas.—R. O. Kapp: Low Power-factor.

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

THURSDAY, JUNE 30.

INSTITUTION OF CIVIL ENGINEERS (Engineering Conference), at 10 a.m.—W. W. Grierson: The Use of Reinforced Concrete on Railways.—H. J. Fereday: Impact Tests and Allowances.—A. H. Hall: The Influence of the Automatic and Semi-automatic Machine on the Skill and Resourcefulness of the Mechanic and Operator.—A. Musker: Mechanical Appliances and Labour in Loading and Unloading Ship's Cargoes.—Prof. W. E. Dalby: The Elastic Limit.—Prof. E. G. Coker: The Effect of Scratches in Materials.—C. P. Sandberg: Damage to Tires and Rails caused by Brakes or Slipping Wheels.—G. Hatton: The Existing Practice of Inspecting Work and Materials.—M. E. Denny: The Design of Fabricated Ships from the Labour-saving Point of View.—J. C. Telford: Economy of Labour on Shipbuilding as effected by Fabricated Ships, etc.—E. R. Mumford: Recent Tank Research in Screw Propellers.—E. H. Richards and M. G. Weekes: Straw Filters for Sewage-purification.—J. Haworth: Activated Sludge.—J. D. Watson: De-watering Sludge.—J. Dalziel: Battery Locomotives.

INSTITUTION OF MECHANICAL ENGINEERS, at 10.15 a.m.—Conference on the Means of Increasing the Thermal Efficiency of Heat Power Plants.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Sir J. J. Dobbie and Dr. J. J. Fox: The Absorption of Light by Elements in a State of Vapour. The Halogens.—Prof. W. A. Bone and the Late W. A. Haward: Gaseous Combustion at High Pressures. Part II. The Explosion of Hydrogen-Air and Carbon-monoxide-Air Mixtures.—Prof. A. E. H. Love and F. B. Pidduck: Lagrange's Ballistic Problem.—J. Proudman: The Principles of Internal Ballistics.—R. H. Fowler: A Simple Extension of Fourier's Integral Theorem and Some Physical Applications in particular to the Theory of Quanta.—Capt. D. Brunt: The Dynamics of Revolving Fluid on a Rotating Earth; and other papers.—The following papers will be read in title:—Takeo Shimizu: A Preliminary Note on Branched α-ray Tracks.—Takeo Shimizu: A Reciprocating Expansion Apparatus for detecting Ionising Rays.—Prof. R. W. Wood: The Time Interval between Absorption and Emission of Light in Fluorescence.

FRIDAY, JULY 1.

INSTITUTION OF CIVIL ENGINEERS (Engineering Conference), at 10 a.m.—R. G. H. Clements: Road Vehicles and their Relation to Road Surfaces.—A. Dryland: Advantages of Bituminous Macadam.—C. H. J. Claytan: The Conservancy and Maintenance of Rivers from the Point of View of Land Drainage.—R. F. Grantham: The Effect of Sluices and Barrages on the Discharge of Tidal Rivers.—G. E. W. Cruttwell: The Utility of Models for Estuarial Experiments.—H. C. Reid: The Relative Advantages of Dredging and Training-walls in Estuaries.—E. Latham: The Use of Inertia Gauges in Pile Driving.—A. L. Bell: The Bearing Power of Soils.—Sir James McKechnie: Internal-combustion Engines with Large Cylinders.—Sir Vincent L. Raven: The Mechanical Advantages of Electric Locomotives compared with Steam.—T. Crook: The Effect of the War on Mineral Supplies.—M. Deacon: The Utilisation of Exhaust Steam in Turbines.—W. C. Mountain: Steam *versus* Electric Winding.—S. Cowper-Coles: The Relative Values of Protective Metallic Coatings for Iron and Steel.—J. Richardson: Recent Progress in Large Diesel Engines for the Mercantile Marine.—R. J. Walker and S. S. Cook: Experience with Marine Turbine Reduction-gears.—E. Sandeman: Compensation Water.—F. W. Macaulay: Pipes for Pressure Conduits.—Dr. H. Lapworth: The Relation of Run-off to Rainfall.—Economic Limits of Distribution from Coal-fired Stations.—B. Welbourn: Low-voltage Overhead Distribution.

INSTITUTION OF MECHANICAL ENGINEERS, at 10.30 a.m.—Conference on the Means of Increasing the Thermal Efficiency of Heat Power Plants.

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