THURSDAY, AUGUST 8, 1918.

AGRICULTURE IN THE WESTERN STATES.

(1) *Western Live-stock Management.* Edited by Prof. Ermine L. Potter and others. Pp. xiv+462. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 10*s.* net.

(2) *Soil Physics and Management.* By Profs. J. G. Mosier and A. F. Gustafson. (Lippincott's College Texts: Agriculture.) Pp. xiii+442. (Philadelphia and London: J. B. Lippincott Co., n.d.) Price 8*s.* 6*d.* net.

THE Anglo-Saxon race always tends to look westwards in time of trouble, and it has usually found comfort there. Horace Greeley's famous advice, "Go west, young man," expresses a deep-seated feeling which years of emigration have only served to intensify. Once again the West is looming large in the history of civilisation, and this time the Allies are looking there for food and men. The books before us deal with the agricultural conditions, and are, therefore, assured of a hospitable reception from agricultural students.

(1) Prof. Potter, of the Oregon Agricultural College, breaks new ground in his treatment of "Western Live-stock Management," and gives an account of what Western stock-keepers are actually doing in the way of raising and feeding their cattle. Real improvement, the author insists, must be based on accurate knowledge of present practices.

By the West the author understands the region lying between the one-hundredth meridian and the Pacific Ocean—the western parts of the Dakotas, Nebraska, Kansas, and the eleven States west thereof. In the main it lies high, most of it above 2000 ft.; otherwise, however, there are great topographical diversity, immense plains, rolling hills, and the wildest and most rugged mountains. Generally speaking, the soil is good. Climatically, the most notable characteristic is the low rainfall; excepting the western parts of Oregon and Washington, almost the entire region has less than 10 in. of rain per annum. The dry climate and high altitude make the summers cool, particularly at night; the winters are mild, except in the north, and, as their coolness is mitigated by the dryness, they are more comfortable for men and beasts than those in the eastern States.

These soil and climatic conditions determine largely the type of husbandry, and it is not surprising that grazing is the main industry. Most of the land still belongs to the United States Government, and is called Federal or Government land; a good deal of this is forest reserve grazed only by those possessing permits from the forest supervisor. The rates payable for sheep are 15–16 cents per head per annum; for cattle, 60–64 cents; for horses, 75–80 cents; and for pigs, 36–38 cents. In Texas, however, much of the land is "deeded" in private ownership, whilst elsewhere there is a good deal of unappropriated land not reserved for forests and not hitherto thought good enough for homesteading. This "free range" amounts to 290,000,000 acres, but it is not so helpful as it looks to the man who wishes to make a living out of nothing, because no one is entitled to take steps to save hay; if anyone does so he cannot prevent someone else from making off with it.

Most of the ranges are covered with sage brush in the north, and with chaparral and similar shrubs in the south. Scattered throughout is a certain amount of grass, which, however, tends to grow in clumps or bunches, instead of scattering over the surface as a sod: hence the name "bunch grass" generally given to grasses in the region. As might be expected, the stock-carrying capacity is low. On a good Leicestershire pasture one acre satisfies one bullock for the season; on a Western range 30–40 acres would be required in the summer and an additional area in winter. Improvement comes as soon as tillage land is added; dry farming has already done something in this direction, and may do more. Still greater improvement can be effected by modifying the grazing system. Most of the range grasses reproduce by seed, and if they are eaten down so closely that they never mature seed they are finally killed out; on the other hand, if they are allowed to form seed they can hold their own indefinitely. By arranging to defer the grazing until after seeding time on one-quarter of the range each year, it is possible to ensure a thorough seeding once in four years, which is found to be sufficient.

It is not necessary to follow the author in his details of management. These are set out clearly, and cannot fail to interest the professed agricultural student who wishes to learn something about ranching.

(2) Profs. Mosier and Gustafson work at the Illinois Agricultural Experiment Station, and while their subject is of general interest, their illustrations are necessarily largely drawn from the great Middle West, and especially from their own State and from Kansas. Soil physics has always attracted much attention in the States ever since Kedzie at Michigan and King at Wisconsin brought out the intimate relationship between cultivation and soil moisture—often a limiting factor in American agriculture. The authors devote a large section of the book to this relationship, and they show that it is much more complex than was at first supposed. Repeated cultivation, for example, which was considered to increase soil moisture and crop production by breaking "capillary films," and thus stopping the escape of water to the surface, is shown in practice to lead to little or no increase in crop. So subsoiling, which had been supposed to increase soil moisture, was found to be ineffective in increasing cereal crops; deep ploughing, however, proved much more useful. An interesting experiment is described that we should like to see repeated in this country. A plot of maize at the Illinois Experimental Station was subdivided; one part was kept well hoed; a second had all weeds destroyed by the hoe, but was otherwise untouched; a third was left un-

touched after sowing, so that weeds came up; a fourth was also left untouched, but sufficient water was added to provide for all the needs of crop and weeds, and to allow of full crop growth if the water supply were the limiting factor. The largest yield—48·9 bushels—was obtained from the plot on which weeds were destroyed; next—with 43·3 bushels—came the well-hoed plot—quite an unexpected result, which, however, leads the authors to an interesting discussion; thirdly came the watered plot with weeds, which yielded ten bushels; and only a little behind—with 7·4 bushels—came the plot that had received no water. It is thus clear that the effect of weeds is not merely to deprive the crop of water. The authors conclude that it must therefore have deprived the crop of food. We would commend to them the papers of Mr. Spencer Pickering on the effect of one growing plant on another.

The chapter on cultivation implements gives illustrations and descriptions of types not generally familiar to English students. Disc ploughs and sulky ploughs are known to some, but listers, spading disc harrows, culti-packers, and weeders will be new to most people here. We should like to have seen this section extended to include a wider discussion of the effect of these implements on the soil—a subject on which the authors could give much valuable information. If need be, space could be found by giving up the sections on fertilisers and some of the geological portions of the opening chapters, which, good as they are, need not necessarily come into a book on soil physics. The authors have done useful service in bringing together so much interesting American material. We may hope one day for a book in which the English and European results will be discussed so that we can compare them with those set out here.

E. J. RUSSELL.

THE INTERNAL EAR.

An Inquiry into the Analytical Mechanism of the Internal Ear. By Sir T. Wrightson, Bart. With an Appendix on the Anatomy of the Parts concerned by Prof. A. Keith. Pp. xi+254+plates ix. (London: Macmillan and Co., Ltd., 1918.) Price 12*s.* 6*d.* net.

THIS volume is a striking example of the co-operative method in scientific research. The problem is the mechanism and functions of the internal ear, especially of the cochlea, a problem the solution of which has enlisted the attention of physicists, physiologists, and anatomists with more or less success. One associates with the cochlea the names of Bowman, Corti, and Helmholtz, besides many others, but this is the first occasion when it has been studied by an experienced engineer working alongside a learned anatomist. Sir Thomas Wrightson, since 1876, has been deeply immersed in acoustics, and he has brought to bear on the cochlea much technical knowledge, derived from wide and varied experience as an engineer. He has associated with him Prof. Arthur Keith, an anatomist, familiar with structure, fertile in imagination, and skilful in interpretation. It would be difficult to conceive a combination of workers more suitable for the investigation of that remarkable mechanism by which sound-waves act on the ear and affect the terminations, or, rather, the beginnings, of the auditory nerve.

The work consists of two parts: (1) The first chapters by Sir Thomas Wrightson, dealing with acoustics chiefly from a theoretical point of view, but always linked with our knowledge of the cochlea; and (2) an appendix, subdivided into parts i. and ii., by Prof. Keith (the curator of the museum of the Royal College of Surgeons), dealing with the mechanism of the internal ear, especially of that all-important portion, the organ of Corti, microscopical in detail, and difficult of interpretation. From one point of view, the sense of hearing is a modification of the sense of touch, which in its turn is a sense of pressure. Between the pressures of sound-waves and the nerve terminals there is an elaborate apparatus for receiving these pressures and converting them into nervous impulses. Further, sound-waves vary in number, or frequency, in amplitude, and in form, and the intermediate apparatus is adapted to the detection of these variations.

Sir Thomas Wrightson discusses the nature of simple, compound, and differential tones, illustrating these graphically by tracings taken by an instrument invented by himself called the ohmograph, and from these tracings information is obtained as to the variations in wave-form, wave-composition, and velocities at different parts of the tracing. A compound wave is resolved into its constituents, each constituent corresponding with a simple tone, or simple pendular movement, blending with others to form a resultant tone. The various curves cross each other at certain points. In an air-wave these points or crossings indicate points of pressure on the fluid in the cochlea, and ultimately on the nerve terminals. Pressures are indicated on the "cross" and the "trough," and thus a wave form, in a simple pendular movement, shows phases. Each complete sound-movement consists of four phases, and each phase acts against resistance more or less elastic. These views are illustrated by elaborate diagrams, and they may be said to lie at the foundation of the author's theory of the cochlea. There is no necessity for calling into play the principle of resonance, and consequently the author entirely abandons the theory of Helmholtz, which was founded on the conception of resonance. It is not in resonance that there is an explanation, but in the detection of variations of pressure.

By means of Seebeck's siren it is demonstrated that several musical tones may be heard without confusion. Sir Thomas Wrightson applies this principle to the phenomena of beats, and to differential and summation tones. It is doubtful, however, whether the ear can distinguish between a push and a pull. The author then proceeds to a consideration of the inner ear, especially as to

changes in the velocity of particles of the perilymph in different parts, depending on the degree of resistance to be overcome.

There is an elaborate chapter on the calibration of the cochlea, showing the ratio of the areas of the various membranes concerned, the measurements of the cochlea at different portions of its course, and the manner in which these influence the hairlets in their bendings. In simple and compound tones, the movements of the hairlets correspond in time with the crests, crossing points and troughs of the waves. Considering the mechanism as an engine, the piston is really the basilar membrane, and the movements are communicated to the membrana tectoria, and through it to the hairlets connected with the hair-cells. At p. 153 the interesting suggestion is made that if it could be proved that a nerve current passed continuously through the points at which the tips of the hairlets impinge on the membrana tectoria, a kind of microphonic action might take place which would modify the conversion of mechanical impulses into nervous irritation—that is, the conversion of mechanical into nervous impulses.

The second part consists of an appendix, in which Prof. Keith gives an historical and critical account of the structure of the ear. The historical portion is especially valuable, showing the development of knowledge from the time of the anatomists John and Charles Bell onwards. Special mention is made of the contributions of Bowman, who was one of the pioneers in describing the structure of the spiral laminæ and basilar membrane and the so-called muscle or ligament. Then followed Corti, Kölliker, Deiters, and Henle, who all investigated Corti's organ and prepared the way for Helmholtz. That German physiologist, taking the cue from Hensen, formulated the view that the function of the organ was to convert compound into simple pendular vibrations. The organ, according to Helmholtz, was analytic in its function. Although it was difficult, almost impossible, for the anatomists, from the small dimensions of its parts, to accept this explanation, it was generally admitted by physicists, as it seemed to meet the difficulties of the case. Prof. Keith submits the matter to a rigorous analysis, and draws the conclusion that there are no anatomical structures which serve as resonators in the cochlea. Generally, he applies Sir Thomas Wrightson's explanation with some modifications and refinements, and he is unable to follow Helmholtz. In particular, he attaches importance to the connection between the hairs or hairlets of the cells and the tectorial membrane. Each small group of hairs, surrounded by the fibres of the membrana reticularis, fits into a depression on the under surface of the membrana tectoria. The basilar membrane, although consisting of fibres arranged in parallel lines, cannot differentiate for separate tones, as the fibres are united side by side and cemented together. It cannot, therefore, be the analytic organ, and the anatomist is obliged to pass upwards to the hairlets and the membrana tectoria.

The impression one has, after perusing this book, is that this study of the cochlea makes the organ complicated and less easy to understand. If analysis takes place in the cochlea, suitable structures must be met with there which physically would suit the purpose; if analysis does not occur in the cochlea, why should there be such differentiation of structure? In other words, how can we account for the elaboration of the basilar membrane, hair-cells, hairlets, and reticular and tectorial membranes, when a direct stimulation of nerve-endings would have served the purpose? Then the principle of resonance, in its real application, would still be serviceable, although the structures were of almost inconceivably minute size. The theory of Helmholtz, although it bristles with obvious difficulties, has at all events the merit of simplicity. We must not forget, also, that minute differences in structure may be morphological other than physiological. This, no doubt, cuts both ways, but it does away with the necessity for having a physiological explanation of every structure, however minute. The Helmholtz theory does not explain, for example, the cochlea in the bird, and it is not the last word in the discussion. It may be contended, however, that it serves a purpose that is understandable. The alternative is to relegate the whole matter to a wilderness of anatomical facts, and we may give up all attempts at explanation by the hypothesis that analysis of compound tones—in short, musical analysis—is a function of nerve-cells in the grey matter of the cerebrum, of which we know next to nothing.

Both authors deserve great credit for a valuable contribution to our knowledge of the subject. The illustrations are admirable, and there are many new sections prepared by Prof. Keith. The reasoning is lucid and suggestive. J. G. M.

OUR BOOKSHELF.

L'Evolution des Plantes. Par Prof. N. Bernard. Préface de J. Costantin. Pp. xxxii+314. (Paris: Librairie Félix Alcan, 1916.) Price 4·55 francs.

NOËL BERNARD was elected professor of botany at Poitiers in 1908 and died, at the age of thirty-six, in 1911. Prof. Costantin, in a preface written at the request of Madame Bernard, gives an interesting account of the life and work of his old pupil. Bernard was a man of wide culture and considerable ability, who devoted most of his scientific life to the experimental investigation of the germination of orchids, with special reference to their symbiotic association with fungi. The concluding chapter of this posthumous volume is a reprint of the introduction to his important paper on "L'Evolution dans la symbiose" published in the *Annales des sciences naturelles* in 1909.

The book is characterised by conciseness and clearness, qualities which one expects in the writings of French authors. The first part treats of the general laws of evolution, the evolution of the individual soma and of sexual reproduction, the idea of species, the inheritance of characters,

species and varieties, Mendelism, and other subjects inseparable from the main thesis. Part ii. consists of concise summaries of the morphology and reproduction of the higher plants, and in part iii. some hypotheses are briefly considered and summed up in the following words:—"Les problèmes sur l'évolution que soulève l'étude morphologique des végétaux resteraient de creuses et inutiles discussions verbales si elles ne devaient pas conduire à des expériences qui permettront sans doute un jour de comprendre cette évolution assez précisément pour la diriger."

"The Evolution of Plants" is a familiar title, allowing free play to an author's imagination: to the layman it suggests a clear picture of the gradual development of plant-life from a speck of living protoplasm to an oak tree. The nearer a book approaches to this standard of precision the less value it has for the biologist. Bernard's book is not of this class; it is a serious contribution which should at least bring home to the layman not only the difficulties of the problems discussed, but also the extent of our ignorance of the lines along which the development of the plant kingdom has proceeded. A. C. S.

Ambulance de "L'Océan," La Panne. Tome i., fasc. ii. Travaux publiés sous la direction du Dr. A. Depage. Secrétaires de la Rédaction: Dr. A. P. Dustin, Dr. G. Debaisieux. Pp. 381. (Paris: Masson et Cie, 1917.)

THE editor and publishers may be congratulated on the attractive way in which this second number of the "Travaux" of the "Ambulance de 'L'Océan'" at La Panne makes its appearance. The papers are copiously illustrated with beautifully executed figures. The researches are naturally devoted to questions concerning the pathology and treatment of wounds and contain many valuable results, which do not admit of a brief account. The following may be referred to as of more general scientific interest. Depage and Maloens show that wounds naturally tend to become sterile; the process, nevertheless, may be aided by the brief action of a strong antiseptic. But prolonged action is injurious to the growing cells. The good effect of Dakin's solution is said to be due chiefly to its solvent action on exudations and dead tissue. Dustin gives a valuable and complete account of the histological changes in injured nerves. De Harven concludes that the choroid plexuses have a secretory function. Sand brings evidence to show that toxic products are produced by the disintegration of injured muscular tissue, whether due to mechanical action or to bacterial infection. Levaditi and Debrez give a detailed investigation of the flora of wounds and of the physico-pathological properties of exudations. Zunz was unable to find "acidosis" (diminution of alkaline reserve) in the blood of wounded men, unless bacterial infection or respiratory obstruction was present. Govaerts points out the importance of transfusion of blood at an early stage after hæmorrhage. Saline solutions were found useless, but the effect of the addition of gum was not tested.

LETTERS TO THE EDITOR.

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Medusoid Bells.

JUST now the sea is full of little tiny bells, and, what is more, they are *all a-ringing*. A few weeks ago I watched some of them developing. Precisely how they do so is not very easy to see, but they develop with amazing rapidity. It is hard indeed to believe that they "grow," cell by cell; rather do they seem just to "come off" the parent stock, one after another, like little curiously formed drops or droplets. They seem to me to be formed *as a whole*, and, apparently (to use Adam Sedgwick's words, written more than thirty years ago), whatever cellular elements they contain "must be regarded as a multiplication of nuclei and a specialisation of tracts and vacuoles in a continuous mass of protoplasm." If this be so, we may throw conventional embryology aside, and conceive of the little bell as being automatically conformed by some physical process akin to the many beautiful phenomena of ordinary drops. But let us pass this problem by for the moment, and merely inquire what modifications of structure would be likely to ensue if the little bell, once formed or partly formed, were to be in a state of vibration; and if at the same time its semi-fluid or colloid and very heterogeneous substance were such as to permit easy transference from place to place of its heavier or lighter particles.

Suppose the little bell to vibrate as other bells do, then its fundamental note will give us four marginal nodes and four corresponding radial nodal lines. We see the latter marked out in our medusoid in the form of four equidistant and exquisitely symmetrical "radial canals"; while at the marginal nodes there appear little aggregations, sometimes of pigment, sometimes of calcareous matter, which we call "eye-spots" or "otoliths." The margin of the bell, if it be free and thin, will tend to be thrown into secondary vibrations, overtones of the fundamental note; and these, as the substance firms, are rendered visible as little rounded lobes and notches set round the bell with perfect symmetry. At the nodal points we may next anticipate that little portions or drops of quasi-superfluous fluid might accumulate, and these would gradually elongate into streamers or "liquid jets," and would vary in form, remaining single or becoming branched, remaining smooth or becoming annulated or beaded, according to the surface-tensions between their substance and the surrounding medium. In any case, they would agree in number and position with the nodes, and where these were numerous and of successive orders, so also would the tentacles tend to correspond in order and magnitude. In short, several of the most important and most conspicuous features of the little "bell" would follow from the simple hypothesis of its intrinsic vibration. Fitzgerald and others have suggested that we may, in like manner, ascribe to vibration the minute and exquisite patterns of many diatoms; Dendy and Nicholson have made use of the same hypothesis to explain the characteristic form of certain sponge-spicules. I have a strong idea that the principle is very far-reaching indeed, and that its bearing on morphological problems will be found to be of great importance.

Our little medusoid is but a single instance, a single type, out of very many. All through the Cœlenterata, in polypes and corals of all sorts, we are confronted

by the phenomenon of geometrical symmetry, and corresponding numerical symmetry of parts in 4's, 6's, 8's, 12's, and so on. We are dealing with what look like vibration-phenomena, with their nodes and internodes; and that is just what I think they really are. Romanes, when he was studying the Medusæ, remarked that "the organism is constructed on what we may metaphorically [?] term a very definite plan"; that its organs had "a very precise geometrical relation" to one another, and that its radial canals were "disposed with perfect symmetry." These are indeed very remarkable features, and the vibration hypothesis seems fitted to account for them all.

What the motions are which the vibrations of the little bell set up in the surrounding fluid, and how these current or vortex movements may react upon the shape of the bell itself, is (I think) another chapter of the same story. D'ARCY W. THOMPSON.

The University, St. Andrews, July 31.

The Encouragement of Invention.

WHILST everyone, including our Government, expresses anxiety to encourage invention in this country, this same Government does what it can to stifle it by taxing royalties on patents as unearned income. If any income is earned, and dearly earned, I should say that it is that derived from patents.

SPENCER PICKERING.

THE EDUCATION BILL.

THE third reading of the Education Bill was agreed to by the House of Lords on Monday, August 5, and it is expected that the measure will receive the Royal assent during this week. The Bill passed through its second reading and Committee stages in the House of Lords without noteworthy changes. Lord Lytton moved the second reading on July 23, and represented the Board of Education during the Committee stage.

Lord Sydenham made a praiseworthy effort to secure the insertion of the words "including instruction in science" in sub-section 1 of the Bill, but unsuccessfully. He pointed out that it is remarkable that the word "science" does not appear in the Bill, and he rightly urged that in the twentieth century no educational measure is complete which overlooks the power of science and the influence of the scientific spirit. Cookery is mentioned in the Bill, yet Lord Lytton objected to the insertion of the words suggested by Lord Sydenham on the ground that reference should not be made to specific subjects of instruction. It was misleading for Lord Lytton to refer to science as an *item* in the curriculum, and to object to the inclusion of the word in the Bill on that account; for Lord Sydenham's amendment had as its intention not so much the prescription of a particular subject of study as the recognition of a prime factor of modern life.

Lord Crewe, leader of the Opposition, paid a high tribute to Mr. Fisher for the masterly way in which he had been able to satisfy so many of the educational needs of the country, and at the same time to commend his reforms both to the House of Commons and to the country. He regarded the concession of the postponement of compulsory continuation education in the case of children between sixteen and eighteen as mainly justified by the impossibility of obtaining the requisite supply of teachers, but was somewhat more doubtful about the reduction of the hours of attendance in continuation schools from 320 to 280.

In reply to some critical observations on the financial aspects of the Bill, Lord Lytton said it was not possible to give an accurate estimate of what the Bill would cost, but the largest item would be the expenditure on continuation schools. In England and Wales, with a population of 36,000,000, the expenditure on secondary and higher education is 6,500,000*l*. For the same purposes Prussia, with a population of 40,000,000, spends 10,000,000*l*., and in the United States, with a population of 91,000,000, the expenditure has risen from nearly 38,000,000*l*. in 1913 to 44,000,000*l*. in 1916. In view of these comparisons, Lord Lytton asked: Could we afford to neglect further provision for higher education? We spend 30,000,000*l*. on elementary education, and do not get the full benefit of the expenditure.

These comments by the Government spokesman for the Bill seem to be somewhat disingenuous, seeing that the Bill provides no guarantee of any sort of the much-needed development of higher education in the only real sense—that is, of persons *above* the age of eighteen. This is distinctly a blot on the Bill, the more noticeable because no undertaking has been given by Mr. Fisher that adequate provision will be made for the development of university education and the encouragement of scientific research. One result of the Bill is sure to be that rate-aid for education and the attention of local education authorities will be fully mortgaged for elementary and secondary education. It will, therefore, be incumbent upon the Government to provide a large part of the funds required for university education.

During the discussion of the Bill in the House of Lords, Lord Bryce expressed the view of an ancient corporation that the Board of Education should hold its hand before creating any more universities in this country. A more helpful suggestion would have been for the appointment of some impartial authority to examine the whole question of the provision of education of university type, and the facilities available to enable men and women to obtain a university education. On one hand, the war has shown that the country needs a much larger supply of highly trained men and women, and, on the other, it is common knowledge that thousands of qualified students are unable to afford a university education, the financial incidents of which will become much more difficult after the war. If the soldier in the trenches, who, by the qualities of courage and cheerful fortitude he has shown during the war, has satisfied the highest tests of education, is found to require further instruction, what would be the verdict in the case of our diplomats, Civil Servants, and Staff officers? It is to be hoped that Mr. Fisher, having achieved a great personal triumph in the passing into law of his Education Bill, will attack the problem of higher education with equal fervour and success.

SCIENCE AND THE CIVIL SERVICE.

THE great technical developments of the nineteenth century, which were due in a large measure to the influence and progress of science, have undoubtedly introduced not only a great transformation in the internal affairs of the country, but also an altered outlook in the external relations of the State. In consequence, many and extensive have been the changes gradually brought about, during the past century, in the duties and responsibilities of the Civil Service. Every Government Department has been affected to some extent; in some of them there have come into existence innovations which are of a very far-reaching character. The outstanding feature of this evolution is that the work of Government Departments has to-day entirely ceased to be of a purely administrative order, whether it be in relation to legislative measures referred thereto for preparation, revision, or criticism, or to the operations conducted therein, or to the sphere of human activity superintended, controlled, or managed thereby. The business of every Government Department is to-day to some extent technical or scientific; in the case of some Departments the administrative aspect predominates; in others it is the technical or scientific aspect that plays the more important *rôle*.

What, then, has the State done to ensure that the *personnel* of the Civil Service, through whom its responsibilities must be largely exercised, shall be properly qualified and equipped for dealing, under present-day conditions, with the social, industrial, and commercial problems which must come before it for legislative, executive, or other action?

One important step certainly has been taken in relation to this matter: it has been definitely laid down that candidates for the Civil Service shall, before appointment, be required to undergo some test as to their knowledge and capacity. To give effect to this decision the Civil Service Commission was, by an Order in Council dated May 21, 1855, appointed to organise a system of examination; the Commission continues to be charged to the present day with the duty of providing suitable candidates for the public services. In 1870 the principle of open competition was introduced for the purpose of filling certain specified situations in the Civil Service, without, however, entirely abolishing "patronage" appointments. Afterwards, in 1876, the clerical establishment of the Civil Service was divided into a higher and a lower division; in 1890 the name "lower division" was altered to "second division," and a provision introduced making it possible for a "second division" clerk to be promoted to a higher division clerkship. It is the clerical establishments of the Civil Service which have alone received attention in the foregoing legislation.

Obviously, it is on the complete success of the competitive examination scheme in force that the welfare of the Civil Service, and, therefore, the protection of the public interest, must depend. It is here that a serious failure has occurred; the open competitive scheme has not been an entire success; it has been productive of a very unfortunate result. The system of marking adopted in the examination favoured candidates whose education consisted largely in the learning of ancient Greece and Rome, and handicapped those whose *forte* was science.

Furthermore, in practically every case the officials who have in recent years received "patronage" appointments in the higher division of the Civil Service are men whose education and training have been identical in character with those of Civil Servants entering the Service by open competition. In consequence, at the present day the highest administrative posts in nearly every Department are monopolised by men whose learning is entirely literary. Further, the technical officers—that is, those in whose education science has played the preponderating *rôle*, and on whose skill and knowledge the welfare of many of the public services very largely depends—are almost entirely excluded from a share in the important administrative posts; needless to say, much to the injury of the public services.

Could it be shown that a purely classical or literary education really tends to develop or to produce administrative talent in an individual superior to that which can be obtained by means of a scientific education and technical training, as is sometimes claimed, there might indeed be some excuse for the retention of the principle of selection adopted; but there is none in actual fact. There exists, on the contrary, abundant evidence to prove conclusively that administrative talent is no exclusive privilege or quality of those who have received a purely classical or literary education: the names are familiar, in wide circles, to high and low, of men who have proved themselves capable administrators of the highest order; men, possessing the capacity of a Cromer or of a Kitchener, in whose education instruction in science also occupied a very prominent place; men whose early years were, too, spent in technical spheres.

The opinion has been gaining ground for some time past that the administrative system of Government Departments is unsatisfactory. The extracts from the reports of the Exchequer and Audit Department published from time to time, wherein publicity is given to the defects in the administrative arrangements in connection with the public services, have provided, in relation to such matters, authentic evidence tending to confirm, in the public mind, the unfavourable opinions that prevail so widely as to the unbusinesslike methods of the Civil Service and the general lack of capacity shown by a large majority of its members. Other authentic evidence is available —some recorded, some not; some public property, some not—which provides an indication that scientific knowledge and technical experience are held in disrepute in many, happily not in all, Government Departments; and, further, that the profes-

sional opinions of technical officers too frequently are not given the due weight which they deserve. Science has done much for the Civil Service; it has not, in return, received the recognition which it merits.

The question arises: How can the defects and abuses known to exist in the Civil Service be best corrected? Remedies there are, some of which have been made public. Such remedies are not competitive *inter se*: they can be applied concurrently, and are capable both of promoting the welfare of the Civil Service and at the same time of adequately protecting the public interest. The report of Sir J. J. Thomson's Committee on the position of natural science in the educational system of Great Britain (Cd. 9011) contains two important recommendations having these objects in view, viz. (*a*) that all candidates for the competitive examination for the Home and Indian Civil Services should supply evidence of a continuous training in science extending over several years; and (*b*) that many posts in the public services should be filled by men selected, not by the ordinary competitive examination, but, at a riper age, on the ground of high scientific qualifications and professional experience.

In view of the present organisation of the Civil Service, it is very certain that the adoption of the first of the foregoing recommendations alone, as a solitary and isolated measure of reform, will not cure the defects known to exist in the Service. The scheme will do little to provide the Civil Service with a sufficient number of men of high scientific attainments and proficient technical knowledge capable of administering the affairs of a modern State in the spirit of progressive knowledge; it will not remove the schism between the administrative and technical staffs of the same Department, a schism which, unfortunately, exists in some Departments to-day.

As regards the second of the above recommendations, presumably the intention is that the men of riper years selected on the ground of professional experience shall fill some of the high administrative posts in the higher division. If this is so, the recommendation is an admirable one and worthy of immediate adoption. But the question arises whether the State will provide remuneration at a rate high enough to secure for the public services men of sufficiently good abilities. Unless it does so, nothing will be gained by the adoption of the recommendation.

A Government pension under the special provisions contained in section iv. of the Superannuation Act, 1859 (22 Vict., c. 26)—*i.e.* one calculated at a higher rate than the ordinary scale—might possibly, in some instances, have been considered by candidates a sufficient compensation for the lower rates of salary prevailing in the Civil Service as compared with those paid by private employers and public corporations. But this feature of the Government pension scheme, provided originally to meet the cases of the kind now under consideration, has ceased to exist: the section of the Act of 1859 in question was repealed by section v. of the Superannuation Act, 1914 (4 & 5 Geo. V., c. 86).

The only effective remedy for curing the ills from which the Civil Service is suffering at the present time consists in a root-and-branch reform, a reform involving the re-fashioning of its entire framework and fabric. No dangerous or expensive experiments are necessary for the purpose of "trying out" and "proving in" a new organisation: a model well worthy of imitation exists in the Swedish Civil Service, with its administrative boards. This model could easily be adapted to meet the requirements of this country; the system of administrative boards would provide a means for utilising to the best advantage the existing administrative and technical officers in the Civil Service by associating with them men of large business and professional experience drawn from outside the public services. A reorganisation on the lines here suggested would naturally bring in its train the recognition of the necessity for a more widespread knowledge of science in the Civil Service. Simultaneously, effect could be given to the recommendation regarding the appointment, to permanent posts of the higher division, of men of professional experience as recommended by Sir J. J. Thomson's Committee. Finally, with the advent of the administrative boards would disappear the methods of administration based on the despot's maxim, *Divide et impera,* methods which continue to have a vogue in certain Departments. Such methods, it is scarcely necessary to point out, are extremely wasteful, and can have no place in any *régime* which relies for its prosperity and efficiency on science.

THE EARLY HISTORY OF THE SOLAR SYSTEM.

A COMMON feature of the older theories of the origin of the solar system is that they all suppose it to have been derived from a more or less symmetrical rotating nebula in a gaseous or quasi-gaseous state. By some process, the details of which differ in different theories, this mass is supposed to have condensed locally to form the sun and planets. A recent paper by Jeans has indicated a way of examining whether such condensation is possible. Viscosity is insufficient to cause a mass so large as the primitive nebula to rotate like a rigid body; each part would revolve practically independently around the centre under gravity, and the matter near any point, on account of the *differences* between the velocities of different parts, would be in a state of rotation with an angular velocity different from that of its revolution as a whole. It is, however, easily shown that the two are of the same order of magnitude. Now a mass cannot condense locally unless the density is so great that mutual gravitation is enough to balance the centrifugal force due to the rotation, and this indicates that, before condensation started at distance r from the centre, the density there must have been at least com-

parable with the mean density of a sphere of radius r and mass equal to that of the sun. Planets having been formed at many different distances from the sun, it follows that the mass must have originally been widely distributed through the system. The distribution of density and velocity being thus known within sufficiently narrow limits, it can be shown by the principle of the constancy of angular momentum that if planets of the sizes of ours were formed, the resulting central body could not possibly rotate so slowly as the actual sun. There is no agency capable of reducing this rotation, and it seems necessary to abandon completely those hypotheses that require the solar system to have been formed by the gradual condensation of a nebula.

We are led to inquire next whether planets could come into being by a more rapid or catastrophic process. Projection from the sun is not a possible origin, for a body started in this way must necessarily strike the sun again on its return and be reabsorbed; further, there is no reason why all should revolve in the same direction. The tidal theory appears to give a better account of the present state of the system. According to this, a star much more massive than the sun approached it very closely, and raised on opposite sides of it two projections, just as the moon raises tides in the earth; but the scale of the disturbance was in this case so enormous that the sun's gravitation was unable to prevent a rupture from occurring. Thus either one or two streams of matter were shot out in a time comparable with a few months or years. Being longitudinally unstable, they broke up into a series of detached masses, perhaps before the parts projected later had actually separated from the sun. That such rupture could occur has been proved by Jeans. The attraction of the disturbing body produced the direct revolution (in the same sense as the motion of the star relative to the sun); some of the revolving matter returned into the sun and gave it a direct rotation. The angular momentum thus acquired was, of course, derived from the transverse motion of the disturbing body relative to the sun.

The size of the deformed body has little influence on its chance of being broken up. Thus the detached masses might well have produced systems of satellites and developed direct rotations in the majority of cases, though complete uniformity could scarcely be expected on account of the number of complicating factors. The fission would cease when the star had receded a sufficient distance; thus the outer nuclei, being the first ejected, would produce most satellites. It seems possible also that some of these would be formed when the nucleus and the sun were on opposite sides of the star, and that the motion would therefore be retrograde. All the bodies, having recently formed part of the sun, would naturally be very hot.

The system after the passage of the star would therefore include a central sun surrounded by a number of heated planets, moving in direct orbits, and attended by satellites; the most remote planets would have most satellites. The rotation of the sun would be direct; the rotation of each planet would be in the same sense as the revolution of most of its satellites, and in most cases this also would be direct, though a few exceptions might well occur, especially in the outermost sub-systems. In every point this agrees with the existing solar system. The heated interior of the earth, the building of mountains by compression, and the present heated state of the greater planets are readily accounted for. The occurrence of three retrograde satellites on the outskirts of otherwise direct sub-systems presents a difficulty, but not, I think, a serious one.

In addition to the planets and satellites, however, there would be a considerable amount of gaseous matter too light to be condensed into the nuclei, and probably consisting mainly of hydrogen. This would be pushed round by the planets as they moved, but its resistance to oscillatory motions would steadily reduce the eccentricities of their orbits, which would initially be considerable. At the same time its own viscosity and diffusion would cause it partly to dissipate into outer space and partly to be reabsorbed into the sun. The zodiacal light is probably the last remnant of it. The actual eccentricities of the planetary orbits being now small, but definitely different from zero, it seems that the time the medium took to degenerate and the time needed to produce a considerable effect on the eccentricities must have been of the same order of magnitude. These are capable of being estimated in terms of the density of the medium, the first being proportional and the second inversely proportional to it. Thus the condition that they are of the same order of magnitude makes it possible to estimate very roughly both the density and the time needed for the changes, which is found to be of the order of 3×10^9 years, as nearly equal as could be expected to the age of the earth indicated by its radio-active constituents (about $1{\cdot}6 \times 10^9$ years). At the same time large condensations would form around the larger planets, and the resistances offered by these would be so great, being proportional to the squares of the masses, that their eccentricities would diminish rapidly. Thus it would be expected that, on the whole, the larger planets would have smaller eccentricities than the smaller ones; this is the case, Mercury and Mars having larger eccentricities than Jupiter, Saturn, and Uranus, and the earth than Neptune. Venus has a somewhat smaller eccentricity than Neptune, but otherwise the agreement is remarkable.

It is certain that on the tidal theory the primitive nuclei must have been very hot, and probably fluid. Whether the larger ones were liquid or gaseous is very doubtful, but the smaller ones, including the asteroids and most of the satellites, can be shown to possess too little gravitative power to have been able to hold together in the gaseous state, and must therefore have been liquid or solid at the start. The satellites probably liquefied almost as soon as they were expelled from their primaries or from the sun, on

account of the reduction in temperature caused by the release of pressure; solidification would occur more slowly. The origin of the asteroids presents greater difficulties. They may have started as independent planets of exceptionally small size; but the fact that none of their mean distances is greater than that of Jupiter, and only one is less than that of Mars, indicates a closer relationship between their origins. Several possible explanations can be advanced; the writer inclines to the belief that they were formed by the close approach of a primitive planet to Jupiter, leading to tidal disruption.

The large size of the moon relative to the earth suggests a fundamental difference of origin between it and the other satellites. It seems likely (indeed, on the theory of a formerly heated earth it is almost certain) that it was once much nearer the earth than it is now, and has receded on account of the friction of the lunar tides. It is natural to think that just before this state of motion with a comparatively small separation between their surfaces the earth and moon formed one body. The rotation would then be so rapid that the longest free period of the mass was nearly equal to the period of the semi-diurnal solar tide, which was consequently enormously magnified by resonance; and it is highly probable that the deformation became so great that the mass separated into two parts. This is not the only conceivable origin of the moon that would be consistent with the tidal theory; but several peculiarities in our sub-system suggest that it is the most likely. No other satellite in the system can have been formed in this way.

As has just been remarked, lunar tidal friction has probably been the predominant cause in the evolution of the earth and moon. No other satellite can raise tides of such importance; but those raised in Mercury by the sun must have been much more effective in reducing the rotation of this planet. Now from the fact that Mercury has no satellite we may infer that it never rotated so fast as the earth did before the moon was formed; and therefore the solar tides will have been able to reduce its rotation so as to make it always keep the same face towards the sun, which again agrees with observation.

Every satellite except the moon has probably been more influenced in its orbital motion by the resisting medium than by tidal friction. The most striking effect of the medium being to reduce the eccentricities of orbits, this accounts for the almost perfect circularity of the orbits of most satellites, especially those nearest their primaries, where the density of the medium was probably greatest. The effect of tidal friction on the eccentricities is not certain, depending on certain unknown physical quantities.

It may be said finally that at every point where the tidal hypothesis has been tested it agrees with dynamical theory and with observation. Several facts otherwise unaccounted for are explained by it, and nothing has yet been discovered to be definitely opposed to it, though a few difficulties, such as the origin of comets and meteor swarms, still remain.

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HAROLD JEFFREYS.

GRASSLAND AND FOOD SUPPLIES.

THE persistent criticism with which the "ploughing-out policy" of the Board of Agriculture has been assailed has been intensified of late with the evidence of failure, total or partial, of some of the crops grown this year on newly ploughed grass land. The columns of the daily Press have been freely used, and have revealed much division of opinion amongst practical agriculturists as to the measure of success or failure in different areas. A new note has been introduced into the discussion by a letter from the Duke of Marlborough in the *Times* of July 30, in which he endeavours to demonstrate from the publications of the Board that the policy is fundamentally unsound.

Basing his criticism upon a leaflet issued by the Board in the spring of last year, his Grace argues that, so far from the data there given proving that an increase of food supply can be expected from the ploughing-up of grass and growing corn, they demonstrate rather that the chances of securing such an increase are very speculative and scarcely likely to be realised. The facts are not disclosed that the leaflet in question deals with the production of winter food for cows, and therefore only indirectly for the human population; and, further, that the dairy farmer is advised that a much greater return of milk-producing food can be expected from growing root crops rather than corn.

The basis of comparison of the feeding values of the crops adopted in the leaflet is quite inapplicable to the assessment of the relative returns for human feeding, since for the latter purpose grass is worthless until converted into other forms which represent only a fraction of the weight of grass harvested, whereas the corn crops, by the simple and expeditious process of milling, yield anything from 60 per cent. upwards of the weight of the grain in a form directly usable for human consumption, whilst, in addition, the accompanying straw, according to its nature, when used for food production purposes, will be roughly equal to one-half its weight of hay. The Duke of Marlborough anticipates this objection by pointing out that, so far as the oat crop, at any rate, is concerned, only a small proportion of it has, in actual fact, been directly utilised for human con-

sumption. That is doubtless true, but the simple fact remains that throughout the anxious days of the food crisis, thanks to the patriotism and courage of the many farmers who voluntarily broke up grass last year, the nation possessed in reserve this valuable store of food available, if required, at short notice, and through the enterprise of the Food Production Department of the Board of Agriculture can face any future emergency with still greater confidence. Individual farmers who secure less than an average crop of corn may suffer loss on this year's crop, but there will be few cases in which subsequent crops, drawing upon the fertility accumulated in the soil throughout the many years under grass, will not satisfactorily redeem any present loss.

NOTES.

THE important question of supplementing supplies of mineral oil by the distillation of cannel coal and allied bituminous minerals has been recently investigated by two separate committees. Whilst the possible production from home sources can amount to but a fraction of the total requirements of motor-spirit, fuel-oil, etc., yet such quantity as might be furnished by the raw materials which are available would undoubtedly tell appreciably in reduction of the tonnage at present required for the importation of oil. That large quantities of oil can be obtained from such material cannot be questioned, but with the reduction in labour, particularly at the mines, and with other demands for constructive material which would be required for the erection of retorts and refineries, the problem of utilising these sources must be dependent on the most economical use of available labour and material under existing conditions. The Government Committee presided over by Lord Crewe considers that a largely increased production cannot be obtained without interfering with other not less important industries (Cd. 9198). The Committee appointed last February by the Institution of Petroleum Technologists has considered the question as an immediate war measure, and as a permanent commercial undertaking and a measure of reconstruction, and in an interim report urges the War Cabinet to lay down a definite policy as to the relative national value of coal and oil, and the provision of the necessary labour, raw materials, and transport; to grant facilities for the erection at suitable centres of plant to those who are prepared to find the capital; to establish at once an experimental station where retorts to a design provisionally approved by the institution may be tested, or, failing such a Government station, to grant all necessary and reasonable facilities to the institution for erecting a station of its own. Whilst present conditions may determine that operations on a commercial scale are not immediately justified, there can be little question as to the economic soundness of such experimental investigations as are required to establish an oil industry as a measure of reconstruction which would be wholly beneficial to the nation.

IN a recent letter to the *Times* Mr. W. J. Malden raises again the old question whether science has done or can do anything for the farmer. The occasion of the letter was Mr. Prothero's speech in the House of Commons containing a tribute to the work of Prof. Biffen on the breeding of wheat—a tribute which most people would think was well deserved. Mr. Malden objects on the ground that "there is nothing new of far-reaching value that the man of science can place in the hands of the farmer at this moment. . . . All that has been done by those practising Mendelism is puny as compared with what Garton and Findlay have done." But no Government Department proclaims their work, and no honours are bestowed on them. The claim would scarcely be worth rebutting did it not represent the attitude of some of the less informed farmers, who hold that there is nothing new under the sun, and that science in particular can teach them nothing. This opinion was at one time fairly common, but it has been steadily dying out during the present generation. In an ancient and highly individualised industry like farming there has been such an enormous variety of practices that, if one goes far enough back over a sufficiently wide field, it is possible to find anticipations of most of the modern improvements. It would be disingenuous to argue, however, that farmers have known these things for generations. It is true that Messrs. Garton and Findlay have improved crops. But they have made no additions to our knowledge; they have kept their secrets to themselves, and no one can practise or develop their methods. It is untrue that their work has remained unrecognised; the community has paid them handsomely for their products. The man of science does not keep his secret to himself, but gives it to the world so that others may benefit thereby; he makes no fortune, and Mr. Malden and those who think similarly should not begrudge him such meagre recognition as he obtains. In the early days of artificial manures it was not uncommon for certain writers to maintain that these substances, being new, could not possibly be useful. Yet the scientific investigator persisted, and to-day the use of artificials is a regular feature of husbandry. We do not wish to fall into the opposite error and overlook the enormous help rendered to agriculture by business men. We must, however, point out that the man of science not only provides a new appliance, but also teaches how and why to use it; all experience shows that intelligent men claim to know why they should do a particular thing in a particular way. This science alone can teach.

THE death is announced, at fifty-two years of age, of Dr. F. E. Batten, physician to the National Hospital for the Paralysed and Epileptic, London, and distinguished by his scientific work in neurology.

THE Conrad Ealte-Brun prize of the French Geological Society has been awarded to Prof. L. Martin, of the University of Wisconsin, for his researches on the glaciers of Alaska.

PROF. THEODORE W. RICHARDS, of the Wolcott Gibbs Memorial Laboratory at Harvard University, has been elected a foreign member of the Accademia dei Lincei, Rome.

THE exploration of the cave known as "Ghar Dalam," Malta, referred to by Prof. A. Keith in NATURE of July 25, p. 404, has been assured for the present year. Besides the sum of 50*l.* given by Sir Thomas Wrightson, Bart., Dr. Robert Mond has placed 50*l.*, and Dr. Charles Singer 10*l.*, at the disposal of the committee in charge of operations.

IT is stated in the *British Medical Journal* that the National Medical Institute of Mexico, which was founded in 1890 for research on the flora, fauna, climatology, and geography of Mexico, and for the exploitation of these resources, has by a recent decree been transformed into the Institute of General and Medical Biology.

WE learn from the *Times* that a special general meeting of the Royal Society was called for Wednesday, July 31, to consider the following motion sub-

mitted by Sir George Beilby and Dr. M. O. Forster:—"That, in view of the war having continued during nearly four years without any indication that the scientific men of Germany are unsympathetic towards the abominable malpractices of their Government and their fellow-countrymen, and having regard to the representative character of the Royal Society among British scientific bodies, as recognised by the patronage of his Majesty the King, the council forthwith take steps necessary for removing all enemy aliens from the foreign membership of the society." The council of the society has had the matter under consideration, and decided to refer the question of expulsion to a conference of representatives of Allied academies to be held in October next. This decision was approved by the meeting, which adopted the following resolution:—"That the delegates of the Royal Society at the forthcoming conference with the representatives of the academies of Allied countries should raise the question of the expulsion of enemy foreign members, with the view of eliciting the opinion of the conference as to the desirability of joint action, and that the subject be reconsidered at a future meeting of the society on the report of the delegates."

THE Board of Agriculture and Fisheries has appointed a Committee to study the life-habits of the honey-bee with the object of improving the conditions under which bee-keeping is carried on in England and Wales, and to investigate the epidemic diseases of the bee, more especially the disease or group of diseases which pass under the name of "Isle of Wight disease." The Committee consists of the Master of Christ's College, Cambridge University (Dr. A. E. Shipley, F.R.S.), Prof. R. C. Punnett, F.R.S. (professor of genetics, Cambridge University), Dr. G. S. Graham Smith, Prof. G. C. Bourne, F.R.S. (professor of zoology and comparative anatomy, Oxford University), Prof. W. Somerville (professor of rural economy, Oxford University), Mr. T. W. Cowan (chairman of the British Bee-keepers' Association), Mr. G. W. Bullamore, Mr. J. C. Bee Mason, and Mr. A. G. L. Rogers (head of the Horticulture Branch, Board of Agriculture and Fisheries). Mr. R. H. Adie will act as secretary. It is proposed to undertake the study of healthy bees at Cambridge and the investigations on "Isle of Wight disease" at Oxford. The Committee will be glad to receive specimens of bees suspected of suffering from "Isle of Wight disease" for examination and experiment. Communications on this subject should be addressed to Mr. Rogers at 4 Whitehall Place, London, S.W.1.

JULY this year stands out meteorologically as wet and rather cool. The especial feature was the heavy rainfall, which was essentially of a thunderstorm type. At Greenwich the aggregate rainfall for the month was 7·37 in., which, according to the series of observations from 1815, is the wettest July on record, and there has only been one wetter month at any time of the year, October, 1880, with 7·65 in. The excess of rain at Greenwich is 5·32 in. In the week ending July 13 the rainfall was 2·48 in., and on the two days, July 11 and 17, in thunderstorm rains, the total measurement at Greenwich was 3·03 in., whilst at Camden Square the rainfall for the same two days was 0·99 in. and at Kew 1·07 in. At Tulse Hill the total rain for July was 7·62 in., and at Wandsworth Common 7·16 in., whilst at Kew the fall was only 4·65 in., and at Camden Square 4·92 in. The weekly weather reports published by the Meteorological Office show that July was wet over nearly the whole of the British Isles, there being an excess of rain in all districts except in Ireland N. The data for the four weeks ending July 27 practically give the rainfall for the whole of July, as the closing days of the month were fine. The wettest district was Scotland N., where the measurement was 4·54 in., and it was 4·50 in. in Scotland E.; the wettest district in England was the S.E., with 4·43 in. The driest district was Ireland N., where the measurement was 2·81 in. Very little rain fell during the opening week, and in many parts of England the period was rainless. The mean temperature at Greenwich was 62·4°, which is 0·4° below the normal, and the absolute highest temperature was 82°. Over the British Isles generally the greatest deficiency of temperature occurred in the second week, ending July 13, when in parts the deficiency was from 3° to 4° F. Sunshine was not very different from the normal.

PROF. P. D. HAHN, whose death at the age of sixty-nine occurred on March 9, had occupied the chair of chemistry at the South African College, Capetown, since 1876. He was a South African by birth, the son of a German missionary stationed in Great Namaqualand. He received his early education in Germany, whither his parents had returned during his infancy. After graduating at Halle he studied in London and Edinburgh, eventually returning to Capetown in 1875. Throughout his career Prof. Hahn manifested a keen interest in the agricultural progress of South Africa; he helped in the establishment of an Agricultural Department for Cape Colony, and the recent institution of faculties of agriculture at Pretoria and Stellenbosch Colleges was an outcome of his advice. He had broad scientific sympathies, however, and urged upon the authorities the need for providing scientific instruction in mining and other subjects, as well as in agriculture. The present School of Mines and Technology at Johannesburg has grown out of the scheme which was devised as the result of his representations to this end, and it was on his recommendation that Government chemical laboratories were established in Capetown. Prof. Hahn was twice president of the Cape Chemical Society, and was also president in 1911 of the South African Association for the Advancement of Science. He had been a member of the council of the Cape of Good Hope University for forty-two years.

M. CHARLES JOSEPH ETIENNE WOLF died at Saint-Servan on July 4 at the age of ninety. He was born at Vorges, near Laon, being an Alsatian by descent. He was appointed professor of physics at Nîmes in 1851, afterwards in succession at Metz and Montpellier; he made pioneer researches at Montpellier, in company with M. Diacon, on the temperature changes in the spectra of metallic vapours. In 1862 he accepted Le Verrier's offer of an important post at the Paris Observatory; the great meridian circle and other new instruments had just been installed, and he took a large part in superintending the scheme of observations, paying special attention to the personal equation. He designed an instrument for its investigation, which was adopted in many observatories. Later he introduced a system of synchronised clocks, first in the observatory, afterwards throughout Paris. M. Wolf made, in conjunction with M. Rayet, the important discovery of the Wolf-Rayet stars with bright-line spectra, which play a large part in theories of cosmogony, a subject on which he was himself a fruitful writer. He investigated the proper motions of stars in clusters, especially in the Pleiades and Præsepe. He took a large part in preparing for the transits of Venus, investigating the Black Drop, etc. His old age was occupied with writing historical memoirs on the former standards of length, on those of the metric system, and on the Paris Observatory. He retired to Vorges, his birthplace, where he de-

lighted to welcome the descendants of his only daughter. In 1914 the German invasion obliged him to leave his home, and he moved to Saint-Servan, where he died. M. Wolf was elected a member of the Paris Academy of Sciences in 1883, and was its president in 1898. He was elected an associate of the Royal Astronomical Society in 1874.

MR. J. REID MOIR describes in *Man* for July a floor recently discovered at Ipswich containing some implements of the Early Mousterian period. A full account of the stratification of the site is given, with drawings of the implements discovered in the course of the excavation. It is at present somewhat difficult to correlate this discovery with that of the Aurignacian floors previously examined in the same neighbourhood, but further research may render this possible. The bones found are identified by Prof. A. Keith as those of an elephant, reindeer, ox (*Bos primigenius*), and goose, many of them showing splitting for the extraction of the marrow

IN the current issue of *Folklore* (vol. xxix., No. 2) Mr. W. Crooke contributes a paper on "The Home in India from the Point of View of Sociology and Folklore." The evolution of the form of the house, which in Western societies is often obscure, can be effectively examined among the castes and races of the Indian Empire, more or less completely isolated by distinctions of race and belief. The various forms assumed by the houses in India are fully described. One of the most primitive is that of the round house, of which there are some survivals, often in the form of churches in Europe, derived from the habit of bending down the pliant branches of some tree like the bamboo to form a temporary shelter. This also accounts for the curvilinear form of the Buddhist stupa, or receptacle for relics. The great pillared halls of the Mogul palaces are similarly derived from the reception pavilions of Central Asia. The occupation of a house marking a crisis in social life, a *rite de passage*, as Continental anthropologists describe it, gives rise to numerous taboos and precautions in order to disperse the evil spirits which occupy the site. The site selection, the laying of the foundation-stone, and the erection of the roof-beams are in the same way regulated by elaborate ceremonies. One curious phase is when a man, acting as a "scapegoat," is sent into the house before the owners occupy it, in order to take on himself the dangers to which they would otherwise be exposed.

THE question of the preservation of paper in India has recently been discussed at the All-India Conference of Librarians at Lahore. Mr. W. Railt, the cellulose expert, who read a paper on the subject, remarked that the problem was not new in England, America, or Germany. But these investigations have little applicability to the problem in tropical climates. Sir Aurel Stein found paper produced from linen or cotton rags in Central Asia in the fifth or sixth century A.D. still fresh and crisp. Complaints of the deterioriation of paper in India date from the introduction of rag substitutes after 1860. Within the next fifty years most of the reports and documents for which such paper was used will, he believes, be unreadable, while those of an earlier era will be quite sound. This is a very serious statement, and the conference passed a resolution advising the Government to undertake an inquiry into the whole subject, and impressing on them the urgent necessity of securing a supply of paper capable of permanent preservation for all records of permanent value. Mr. Chapman, of the Imperial Library, Calcutta, remarked in the course of the discussion that he had made a list of books in that institution published between about 1790 and 1870 the paper of which had perished badly. This list was sent to the British Museum, and the authorities reported that their copies of these books were in perfect condition. The factor of climate is therefore of great importance in the case of books printed on paper made of rags and forms of cellulose.

IN the *Revue Scientifique* for June 8 MM. Sartory and Blaque review the bacteriology of war-wounds. A large proportion of these are infected with various species of bacteria, because the fragments of the projectiles, principally shrapnel, are soiled with earth, and may also carry into the wound fragments of clothing likewise soiled with earth. From about the ninth hour after infliction the microbes that have gained access begin to multiply in the wound, in particular certain anaerobes, such as the *Bacillus perfringens* group and the organism of malignant œdema, which are concerned in the production of gas-gangrene. Then the *Bacillus coli* begins to grow, and by about the twentieth hour streptococci and staphylococci appear, associated with numbers of saprophytic bacteria. Supposing that the patient survives and gas-gangrene does not occur, the wound becomes an ordinary suppurating one from the seventh to the twentieth day. At this stage the anaerobes disappear and the pus-producing organisms become paramount—cocci, *Bacillus coli*, *B. proteus*, and *B. pyocyaneus*.

DR. JAMES RITCHIE, in the *Scottish Naturalist* for June, records the occurrence of a giant squid (Architeuthis) stranded in the neighbourhood of Skateraw, on the eastern coast of Haddingtonshire, on November 2, 1917. The body had suffered mutilation at the hands of the curious before Dr. Ritchie arrived on the scene, but he was enabled to obtain important notes and measurements, which he records at length in his communication. The body, from the tip of the tail to the base of the tentacles, measured 5 ft. 9 in.; while the stalked arms measured 14 ft. Unfortunately the beak had been removed, as also had the pen, though portions of this were found on the beach. The eyes also were missing, a fact which is the more regrettable, since these afford valuable specific characters. From a careful study of these remains the author is of opinion that this squid may be identified as *Architeuthis harveyi* of Verrill, and marks the only definite occurrence of a giant squid on the coast of Great Britain.

TWO valuable papers, on the morphology of the vertebræ of the Temnospondyli and Stegocephalia, and on the osteology of some American vertebrates, by Mr. S. Williston appear in Contributions from the Walker Museum, Chicago (vol. ii., No. 4). The author remarks that while no material differences are apparent between the skulls of Edaphosaurus and Naosaurus, or between the parts of the appendicular skeleton, yet there exist well-marked differences in the spines of the cervical vertebræ, since in Naosaurus these are broadly dilated and thickened at the extremity, while in Edaphosaurus they are slender and pointed. The author is fortunate in being able, for the first time, to describe and figure the complete skull of Naosaurus, inasmuch as this has enabled him to set at rest some doubtful points in regard to this genus and its allies. Finally, the author describes a new genus and species of the Diplocaulidæ. The remains on which the new genus is founded were obtained in the Craddock bone-bed, near Seymour, Texas.

THE recently issued Bulletin of the Imperial Institute (vol. xv., No. 4) contains several papers of

economic importance. Among them may be mentioned a useful article on the peas and beans of commerce, and another on the various useful fibres of the Belgian Congo. In view, however, of the world's demand for oils and fats for the manufacture of margarine, the article on the oil-seed industry of Rhodesia is worthy of more particular attention. It seems probable that the cultivation of oil-seeds may become an important industry in Rhodesia. Ground-nuts and sunflower-seeds are the only oil-seeds produced commercially at present, but experiments conducted at the agricultural stations indicate that success may attend the cultivation of other oil-seeds. Castor-seed, sesame, and linseed have recently been sent from the Government gardens, North Rhodesia, to the Imperial Institute, as well as sunflower, and have been found to be entirely satisfactory. Before the war sesame-seed was chiefly crushed on the Continent, and the inclusion of its oil in margarine was compulsory. This, on the outbreak of the war, naturally raised the price of sesame oil considerably, and cheaper and equally good oils were adopted as substitutes. If, however, the Rhodesian sesame-seed can be successfully grown and the oil be procured in this country at a cheap rate, the industry may well have an important future before it, for sesame-seed is now being crushed in this country, and the Rhodesian seed will be a valuable addition to the available supply of seed.

ACCORDING to the *Revue générale de l'Electricité*, a Dutch company has taken out French Patent No. 480,857 for a thermic telephone, in which the strength of reproduction of the voice may be regulated as required. The result is obtained by giving the instrument the form of groups of thermal conductors, superposed or placed side by side in the same box, and mounted on removable supports and conductively joined to each other, so that the number can be chosen according to the requirement of the person using the telephone.

FRENCH Patent No. 483,519 describes an incandescent electric lamp with spiral filament capable of giving a concentrated beam of light and high candle-power. This is effected (*Revue générale de l'Electricité*, April 20) by using a projecting mirror cooled by the continuous circulation of water or air between the walls of which it is formed. The mirror is placed inside the bulb of the lamp. The cooling water may be passed through coils, and it helps at the same time to cool the gas and increase its circulation in the bulb. Thus it is possible to raise the temperature of the filament and so obtain a greater candle-power and efficiency.

OCCASIONALLY an alloy of two or more metals which is known to possess good elastic properties will, for some unknown reason, fail under a stress much below its normal breaking stress. The cause of such failures in the case of brasses of the Muntz metal type has been investigated by Messrs. P. D. Merica and L. W. Schad, of the Bureau of Standards, whose work on the subject forms Scientific Paper 321 of the Bureau. As brasses of the type considered consist of solid solutions of α and β brass in each other, the authors have measured the rates of expansion with rise of temperature of the two constituent brasses. They find that while α brass expands at a nearly uniform rate from 100° C. to 600° C., β brass only expands at the same rate over the range 100° C. to 300° C., then at a considerably greater rate to 500° C., after which it again agrees with the α brass. From this it follows that when a brass containing both constituents is rapidly cooled over the range 500° C. to 300° C., stresses will be set up at the surfaces of contact of the two constituents, and in one case the decrease of strength of a specimen treated in this way amounted to 2000 lb. per sq. in. The authors state that other alloys are to be investigated, and the results will be awaited with much interest.

AT one time there were a good many three-cylinder locomotives in this country, but they were all of the compound type. Mr. H. N. Gresley, of the Great Northern Railway, has brought out a three-cylinder high-pressure engine operated by two valve gears, and a description of this locomotive will be found in the *Engineer* for July 26. The engine, which is an eight-coupled coal locomotive, has been at work for some time, and appears to be fulfilling all expectations. Charts taken on a dynamometer car show that the engine starts much more easily than a corresponding two-cylinder engine, and owing to its more uniform turning moment the draw-bar pull is exceptionally steady. At present this engine forms a class by itself, but after the war is over it is probable that others of the same type will be constructed.

SOME methods of reclamation of industrial waste products are described in an article in the *Times Engineering Supplement* for July. In some cases metal cuttings and scrap from machine tools have been subjected to treatment for the recovery of the oil used in cutting prior to disposal of the scrap to metal refiners. One case is cited of a prominent motor-car manufacturing firm recovering 1200 gallons of cutting oil per week, the oil being used over and over again on similar work, while the fresh oil necessary to make up for wastage amounted to only 10 per cent. of the total required. A turbine-centrifugal separator is used, with steam, for the dual purpose of propellant and liquefier. The oil contained in cotton-waste and cloths used for cleaning machinery, mopping up oil, etc., deserves more consideration than it usually receives. In numerous cases such materials, thrown away after first use, are of greater value than new materials. In an installation of the most complete type the dirty material is first passed through a turbine separator in order to extract the oil, which is ready for use again after purification. If the material has been used on comparatively clean work, it is ready for re-use as it comes from the separator; otherwise it is advisable to wash it in a machine resembling the ordinary laundry machine, and then partially to dry it in a hydro-extractor prior to final drying in cabinets or automatic rotary machines. With such a plant, turning out six tons of clean, dry rags per week and involving a capital expenditure of 2200*l*., a saving of about 450*l*. has been effected in three months' working. Sixty-seven tons of rags and 4080 gallons of oil were reclaimed in this period, and the reclaimed oil was used as fuel for Diesel engines.

THE twelfth annual report of the Executive Committee of the British Science Guild, just issued, contains a special reference to the aims and objects of the British Scientific Products Exhibition, to be opened next week at King's College, London. A series of interesting memoranda issued by the Education Committee is also included, dealing respectively with the Education (No. 2) Bill, scholarships for higher education, and the teaching of science. In a report on the introduction of the metric system, which was recently brought before the Ministry of Reconstruction, some concrete suggestions to facilitate legislative compulsion are made. Importance is attached to the adoption of metric measures in Government publications inviting tenders, etc., and their general introduction in schools and colleges. A report on the British dyes industry directs attention to the very large capital employed for this purpose in Germany and to the need for a complete statistical survey of the present condi-

tion of the industry in this country, with the view of preventing overlapping of effort. A full account is given of the addresses delivered by Lord Sydenham, Sir Algernon Firth, and Sir Henry Newbolt at the annual meeting on June 19. The offices of the Guild are at 199 Piccadilly, London, W.1.

MR. BERNARD QUARITCH, having acquired the stock of "Biologia Centrali-Americana" from Dr. F. Du Cane Godman, is offering the work, either complete or in separate sections, at reduced prices. A prospectus explaining the origin and development of the "Biologia Centrali-Americana," and giving particulars of the contents of each of the sixty-three volumes, has been prepared by Mr. Quaritch, and will be sent to readers of NATURE upon application being made for it to 11 Grafton Street, New Bond Street, W.1.

OUR ASTRONOMICAL COLUMN.

THE PERSEID METEORIC SHOWER.—The maximum of this brilliant annual meteoric shower will probably occur on Sunday night, August 11, and the best period for observation may be expected after midnight. The first traces of the shower were recognised on July 8 by Mrs. Fiammetta Wilson at Totteridge and by Miss A. Grace Cook at Stowmarket. A meteor was mutually recorded by them on that date and found to be a true Perseid, with a radiant point at 8°+49°. Another member of the stream was seen by the same observers on July 12, and the activity of the display has been increasing nightly. On August 5, at 13·54 G.M.T., a splendid Perseid brighter than Venus was seen by Mr. Denning at Bristol traversing a path from 269°+84½° to 230°+65°. With suitable weather there should be a rich display of Perseids this year.

RADIAL VELOCITY OF β CANIS MAJORIS.—In 1908 the star β Canis Majoris, of magnitude 2·0 and type B1, was found by Albrecht to be a spectroscopic binary with the very short period of about six hours. A further study of the star has recently been made by Dr. F. Henroteau, in which special efforts were made to secure continuous series of plates during the same revolutions (Lick Obs. Bull., No. 311). The mean velocity, of +35 km. per second, appears to be constant, but the range of velocity has been found to vary very considerably from one period to another, being sometimes as low as 3 km., and at other times as much as 18 km. per second. This variation in range shows no simple periodicity, but does not seem to be a discontinuous function. It is remarkable that while there is no period which connects and represents the different minima of velocities, a period of 0·25714 day, starting from a given maximum, always corresponds with either a maximum or a minimum of the velocity curve. It has been further noted that the spectral lines undergo a periodic change in width, the amplitude being always approximately the same, and the period 0·25130 day. This variation seems more likely to be due to physical changes in a single body than to the combination of two spectra, but no satisfactory explanation of all the peculiarities of the star has yet been found. Adopting Mitchell's parallax of +0·009″, the star would be about 1000 times as bright as the sun.

RELATIVITY.—A paper by Jun Ishiwara on relativity (Proceedings of the Tokyo Mathematico-Physical Society, second series, vol. ix., No. 16, May, 1918) is based on the assumption that the gravitation potential is completely represented by a scalar quantity ψ; the components g_{hk} of the fundamental tensor of the time-space transformation and the scalar c (velocity of light *in vacuo*) are functions of ψ. It follows that the field-intensity is given by the gradient of ψ in space. The expressions for g_{hk} and c in terms of ψ are found with the aid of Poisson's equation, and the author deduces in an independent manner the same expression for the advance of the perihelion of a planet during one revolution as that already given by Gerber and Einstein, which is known to agree with the observed value in the case of Mercury.

Dr. L. Silberstein demonstrates in Monthly Notices of R.A.S. (May, 1918) that an unexpected consequence of Einstein's theory is that all homogeneous bodies must be spherical; he considered that this was a strong argument against the truth of Einstein's views. Prof. Eddington, in the discussion which followed, remarked that the principal bodies known to us in space do, in fact, approach very closely to the spherical form, and, further, that a perfectly homogeneous body is difficult to conceive, since there must be some differences of pressure, and therefore of density, in different portions of it.

THE SUPPRESSION OF BODY-VERMIN.

A COMPREHENSIVE paper entitled "Combating Lousiness among Soldiers and Civilians," by Prof. G. H. L. Nuttall, appears in *Parasitology* for May (vol. x., No. 4). The paper is one of a series which, when complete, will constitute an exhaustive monograph on human lice. It brings together, not only the available published information, but also that resulting from hitherto unpublished research work, partly the author's own, and partly that of others contained in reports to the War Office, which he has been permitted to use. Prof. Nuttall has generously presented a special edition of three hundred copies of the paper to the Allied Armies; and, in view of the recently established fact that trench fever is conveyed by lice, this should prove a very timely gift.

The paper comprises 176 pages, with four plates and twenty-six figures in the text. Most of the pages are devoted to the practical consideration of louse destruction, a great deal of the experimental evidence being given in detail. The results obtained demonstrate that nits are killed by dry heat at 65°–70° C. in one minute, and at 55°–61° C. in ten minutes, the active stages being killed by dry heat at 65°–70° C. in one minute and at 55° C. in five minutes. After allowing for a margin of safety in practice, immersion in hot water at 70° C. for a minute or two is amply sufficient to destroy lice, while 55° C. for ten minutes is equally effective, a point of great importance in relation to the washing of flannel garments.

Singeing, sun-baking, and the use of hot flat-irons are briefly dealt with. The various methods devised for disinfestation by hot air and steam are treated of at length, and illustrated by text-figures of disinfestors improvised for war purposes, together with plates depicting the more elaborate forms of disinfectors designed for use in peace-time. We agree with the author that apparatus designed with a view to high efficiency against the resistive spores of bacteria is not adapted for rapid and economical use against lice. It should be replaced by more commodious hot-air and steam huts, or disinfestors planned on the improvised railway vans said to have been so successful in the East. Designs of this type of chamber should also be adapted for steam or motor lorries, as well as trailers, which could, if necessary, be horse-drawn.

Steam gives results superior to hot air if the destruction of pathogenic bacteria is an object, but dry heat possesses many advantages over steam if the destruction of body-vermin is the end in view. The use of sulphur is treated of at some length. We endorse the author's remarks as to the failure of sulphur vapour to destroy all the nits exposed to it, while its relatively high cost, the danger of injury to clothing, and its slow action are further disabilities of the method.

In the section dealing with insecticides and so-called repellents, the results of the great mass of experimental work are tabulated in detail, an unavoidable course owing to the wide diversity of method employed by the various workers. In these experiments lice and nits were immersed in, brought into contact with, and submitted to the action of the vapour of various substances and preparations.

We heartily congratulate the author on this valuable and exhaustive paper, and commend its careful study to all those concerned with the suppression of body-vermin.

MARINE BIOLOGY AT PLYMOUTH.

THE latest issue (vol. x., No. 4, May, 1918) of the Journal of the Marine Biological Association contains several papers of interest to fisheries investigators. Mr. D. Ward Cutler writes on the question of age-determination in fishes by inspection of the growth increments in the scales. The latter are built up of "sclerites," which are arranged in concentric, or rather confocal, bands, the focus being somewhere near the middle of the scale. Some of the bands of sclerites (those formed during the summer months) are relatively wide; the others that are formed during the winter months are relatively narrow. Thus the scale shows "annual rings of growth."

Mr. Cutler graphs his measurements of the sclerites, but gives a very bare account of the construction of the figures, so that his charts are not easy to understand. Plaice and flounders were kept in tanks artificially heated or cooled or of normal (seasonal) temperature. Some of the normal tanks were well supplied with food, and others were scantily supplied. Thus it became possible to distinguish between the temperature and the nutritional factors of growth. The latter do not affect the formation of broad (summer) and narrow (winter) bands. Abundant food leads to the production of many sclerites and meagre nutrition to few, but the relative width of the sclerites (and therefore of the confocal bands) is independent of food supply. On the other hand, the temperature of the water in which the fish lives influences directly the size of the sclerites, for those formed during phases of relatively high sea-temperature are large, while those formed during colder periods are small. They are formed in bands, and so the relative width of the latter reflects the annual wave of temperature change—even, Mr. Cutler suggests, the aperiodic fluctuations of the latter. All this is in line with other work on the metabolism of marine animals; it is really a case of velocity of chemical reaction, being proportional to some function of the temperature at which the reaction occurs. When the sea is relatively warm assimilation is speeded up, respiratory movements in a fish are quickened, and feeding increases. Decrease of temperature reduces tissue waste, and events happen in the opposite direction. But assimilation increases absolutely during the warmer phases, and so the marine fish "puts on flesh" during the summer months.

In the same journal Miss Marie Lebour gives extensive lists of the nature and relative abundance of the organisms forming the food of small, larval, and post-larval fishes of various species. She confirms, in general, but greatly amplifies, the observations of previous workers on the same subject. Even in quite small fish of some species, and with variety of food available, there is selection and quite evident preferences for certain food organisms. The paper is illustrated with some very admirable drawings of the heads of post-larval Pleuronectid fishes. J. J.

SCIENCE IN HORTICULTURE.

THE third annual report of the Nursery and Market Gardens Industries Development Society, Turner's Hill, Cheshunt, shows that continuous progress is being made in the application of science to horticultural practice. The fertiliser experiments are of considerable interest, and bring out the marked effectiveness of nitrogen compounds, especially of stable manure, in the growth of cucumbers, and their relative ineffectiveness in the growth of tomatoes. It is not definitely settled whether this result arises from some fundamental difference in the method of nutrition of the two plants, or simply from the relative drafts they make on the soil. The ineffectiveness of phosphates, both on cucumbers and tomatoes, is remarkable, and merits closer attention. An important technical matter is the demonstration that a relatively inexpensive mixture of artificial fertilisers gave larger returns than a mixture made by some of the best growers based on the best practice of the district. Fertiliser trials need considerable time for their execution, and it must be some time still before the experiments have yielded all the information they are capable of giving. They seem to support the old idea of an antagonism between fruiting and vegetative growth, for the methods which would normally produce the largest plants do not necessarily produce the largest amount of fruit.

Some interesting observations are recorded on the physiological conditions in cucumber-houses. There was found to be an appreciable correlation between the area of the seed-leaves and of the first rough leaf, and also a small correlation between the size of the seed-leaves and the dry weight after thirty days. Seedlings with the longest stems gave the largest crops. All these points are of great importance; it is remarkable that the later history of the plant should be so intimately bound up with its early properties. The grower has room in his houses only for a very limited number of plants, and he cannot afford to keep unprofitable seedlings.

Further experimental work was also undertaken on methods for the partial sterilisation of soil, and a serious combined effort is being made to solve the problems arising when these are applied in practice.

THE PALÆOBOTANY OF NEW ZEALAND.[1]

THE late Dr. Arber's memoir on the earlier Mesozoic floras of New Zealand is a particularly welcome addition to our knowledge of a much-neglected subject. In 1913 Dr. Arber published two papers on fossil plants from New Zealand, but the present paper covers a much wider field and deals very fully with a considerable number of species from Triassic-Rhætic, Jurassic, and Cretaceous strata. The specimens are the property of the Geological Survey of New Zealand, the British Museum, and the Sedgwick Museum, Cambridge.

The author shows that no Palæozoic plants have so far been discovered, and no undoubted examples of Glossopteris are included in the material examined. The genus which most nearly resembles Glossopteris is Linguifolium, instituted by Arber in 1913, but the author does not believe that the two are closely allied. The arguments in support of his view are, however, not conclusive. It is assumed that New Zealand did not form part of Gondwanaland, this term being used by Arber for a Palæozoic continent only, a more restricted usage than that adopted by Suess and some other authors.

[1] "The Earlier Mesozoic Floras of New Zealand." By Dr. E. A. Newell Arber. New Zealand Geological Survey: Palæontological Bulletin, No. 6, 1917.

Dr. Laurent, of Marseilles, contributes descriptions of a few Angiosperms from Neocomian rocks. The account of the Jurassic flora of Waikawa, Southland, includes an interesting description of a remarkable petrified forest composed chiefly of trees of an Araucarian type associated with petrified Osmundaceous stems. Forty-eight species are figured; of these at least fourteen are regarded as new, the remainder being widely distributed Mesozoic types. The admirable drawings and photographs are well reproduced, and there is an excellent bibliography.

This latest contribution by a palæobotanist whose untimely death is a serious loss to science is of great value from the point of view of phytogeographical problems; the author has cleared up several difficulties and corrected erroneous statements frequently quoted from the meagre literature on New Zealand plants. It is to be hoped that this thorough piece of work will stimulate New Zealand students to do their best to obtain additional material from the various localities in the islands, and thus provide data for the continuation of Dr. Arber's memorable work.

A. C. S.

VIBRATIONS: MECHANICAL, MUSICAL, AND ELECTRICAL.[1]

V.—*Brass Instruments and the Low "F."*

LEAVING the pendulums which have only two vibrations at a time, the case of brass instruments with a number of simultaneous vibrations was next considered. It is well known that the vibrations from most musical instruments are what is called compound. They consist of a series of tones of commensurate frequencies sounded together. Thus if the pitch of the note is said to be 100 per second, there is not only a prime tone of this frequency, but also a second tone of 200 per second, a third of 300 per second, and so forth. This law applies to strings, to open parallel pipes, and to a complete cone with its base open. It also applies as a close approximation to the brass instruments in general use. This approximation is traceable to the departure from the strictly conical forms as regards the mouthpiece, the bell, and the special shape of the intermediate portion.

In these brass instruments the possibility of this compound tone, or multiple resonance, is utilised for the production of distinct notes. Thus out of the tones possible to the instrument the player may elicit the set 200, 400, 600, 800, etc.; or the set 300, 600, 900, 1200, etc. These would be said to have the pitches of their primes or lowest components, 200 or 300 respectively. Or, to put it musically, they would be the octave or the twelfth of the fundamental (or *pedal*) possible on the instrument. The pedal of the instrument is not usually employed for musical purposes, but can be sounded if specially wished. Now there is a tradition among players of brass instruments that a note called by them a low "F" can be sometimes obtained. This note would have on the foregoing scheme the frequency $133\frac{1}{3}$. At first the possibility of this "F" seems scarcely credible to the theoretician. But after hearing and producing the note the necessity of accounting for its possibility was forced home.

Really the explanation proves very simple. It usually depends upon two points:—(*a*) The *spread* or *diffused resonance* of the pedal, and (*b*) its intentional *mistuning* with respect to the other notes of the instrument. These are taken in order.

(*a*) For theory shows that, other things being equal, the lower the note of such an instrument, the easier it is to force its vibrations out of tune, sharper or flatter. Thus with the pedal the range of resonance is such that the note may be sounded at any pitch whatever over a range of five or six semitones.

(*b*) Since the law of frequencies 100, 200, 300, 400, etc., is only approximately true for these instruments, in order to secure good relative tuning of the higher notes which are in constant use the pedal (which is not used musically) is purposely mistuned. On some instruments it may be, say, D or E♭ instead of C.

Hence, if the central pitch of the pedal is sharpened two or three semitones—and it is possible to force this note both up and down two or three semitones—it becomes possible to sound the pedal of true pitch C, to sound the low "F," and to sound notes of every pitch between. (This was demonstrated by Mr. White on a euphonium, kindly lent by Messrs. Boosey and Co.) The low "F" is also possible on the bombardon. Both these instruments are characterised by large conical tubing, and the low "F" is obtained by the spread resonance of the sharpened pedal.

In the case of the trumpet, cornet, and French horn with much narrow tubing the pedals are flattened, so that a pedal of true pitch can be obtained only by the spread resonance, and the "F" is impossible. On the trombone, which has much small parallel tubing, the low "F" may be obtained occasionally by the downward-spread resonance of the second partial (or note number two), which is an octave above the pedal. (Demonstration.) The pitches of the notes which have been obtained on six types of instruments by four experimenters are shown in Table II.

VI.—*Monochord Vibrations.*

Consideration was next given to the vibrations of stringed instruments, beginning with the monochord because of its striking simplicity.

From the work of mathematicians (with a little help from experiment) the various possible vibrations of strings, whether plucked, struck, or bowed, have long been well known. But a little reflection will show that many other problems are still left confronting the physicist. For identical strings, excited in the same way, but mounted on different instruments, will produce very different effects on the ear. In other words, the worth of a violin does not lie in its strings, but in its sound-box.

This leads to the inquiry as to what happens to modify the vibrations as, passing from the strings, they reach in turn the bridge, the belly (or sound-board), and the adjacent air.

It is easy to see that this problem is somewhat complicated, since it presents so large a number of variables. Thus there lie at the experimenter's disposal the pitch of the string, its material and dimensions, the place and manner of excitation, the material and disposition of the associated parts of the instrument, the place of observing the belly, the portion of the bridge observed and the directions of its motions, and, lastly, the spot at which the motion of the air is observed. In this way a scheme for more than a thousand observations could be sketched, even for an instrument with but one string.

Hence, no exhaustive treatment of the problem can be quickly obtained. But a beginning has been made, and by very simple means.

In a series of experiments simultaneous records have been photographically obtained of the vibrations of the string and of some other part of the instrument. The monochord was placed on a table and light from a vertical slit was focussed upon the string near its centre. The real image of this slit, crossed by the shadow of the string, was then focussed by a

[1] Abstract of a discourse delivered at the Royal Institution on Friday, March 8, by Prof. Edwin H. Barton, F.R.S. Continued from p. 439.

TABLE II.—*Spread Resonance of Lower Open Notes on Brass Instruments.*

Instrument and Key	Maker	Player		Pedal	(Low "F")	No. 2		No. 3	
Trumpet E♭ in B♭	Boosey	D. J. Blaikley	F F♯ G A♭ A	B♭ (120)	F F♯ G A♭ A	B♭ (240)			
	Brown	E. H. Barton	E F F♯ G A♭ A	B♭	A♭ A	B♭	B		
	Hawkes	,,	A♭ A B♭ B C D♭ D	E♭	D	E♭			
Cornet in B♭		E. C. Pickerill	F.....G A♭ ..	B♭ (120)	F..... G A♭ ...	B♭ (240)			
	Boosey	E. H. Barton	E♭ E F F♯ G A♭ A	B♭	G A♭ A	B♭			
Trombone in B♭	Boosey	D. J. Blaikley	F♯ G A♭ A	B♭ (60)	(E♭) E F F♯ G A♭ A	B♭ (120)		(180)	
	Millereau	E. H. Barton	G A♭ A	B♭	B ..... F♯ G A♭ A	B♭	B..... ..	F	F♯
French Horn in F	Boosey	D. J. Blaikley			C D♭ D E♭ E	F (90)	F♯...A B♭ B	C (135)	
	Boosey	E. H. Barton			E♭ E	F	F♯.....B♭ B	C	C♯
Euphonium in B♭	Boosey	D. J. Blaikley		B♭ (60)	B C C♯ D (E♭) ..... A♭ A	B♭ (120)			
	Besson	E. H. Barton	A	B♭	B C C♯ D (E♭)E..... A	B♭	B		
Bombardon in E♭	Boosey	D. J. Blaikley			(A♭) ..... C D♭ D	E♭			
	Besson	E. H. Barton		E♭ (40)	E F F♯ G (A♭) A ..... C♯ D	E♭ (80)	E		
	,,	A. Wilkinson			E F F♯ G (A♭) ..... C C♯ D	E♭	E		
	Boosey	D. J. Blaikley (March, 1913)		E♭ full	E F F♯ G (A♭) ..... C♯ D fair poor fair full poor fair	E♭ full	E F fair poor		

second lens on to a photographic plate in a dark room. This plate was shot along horizontal rails by elastic cords, which were just slack when the plate received the light. Thus the plate moved uniformly and horizontally, while the shadow of the vibrating string showed its special motion vertically. The corresponding motions of bridge, belly, or air were obtained on the same photographic plate by the light reflected from a tiny rocking mirror, the slight tilt of which was produced by the motion of the part under test. (The principle of this experimental method was then demonstrated, the humped form of the curve due to plucking the string and the two-step zigzag produced by careful bowing being shown.) Fig. 3 gives a diagram of the method for the monochord, also a detail of the rocking mirror for the bridge's motion. Fig. 4 shows photographic traces for the monochord, string, and belly. The two curves alike were taken separately to test if the apparatus worked satisfactorily. The other two curves, slightly different from each other, show the distinction in appearance between the records of a bad and those of a good tone. In this work the assistance of Messrs. C. A. B. Garrett and J. Penzer was acknowledged. In 1914 Prof. C. V. Raman, of Calcutta, by experiments somewhat similar to the above, showed that the forward speed of a string where it is bowed is identical with that of the bow itself.

VII.—*Violin Vibrations.*

If the problems of the monochord were numerous and complicated, those of the violin are still more so, for there are now four strings instead of one; further, all are different in thickness and pitch, and are capable of use in sections of varying length. Again, the sound-

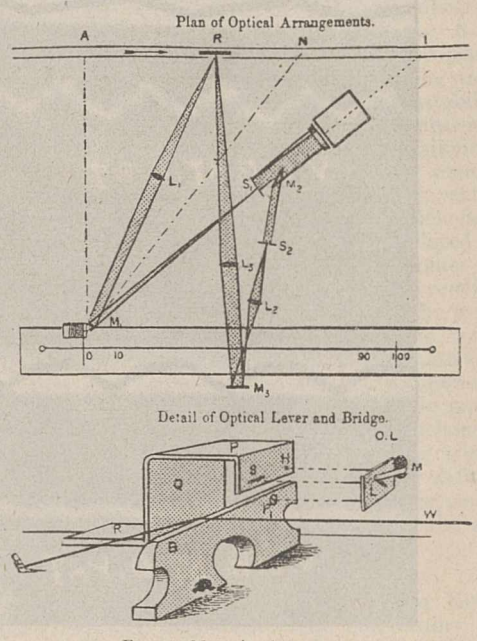

FIG. 3.—Monochord apparatus.

box is curved in a variety of ways. Finally, the reinforcement of the belly is asymmetrical. The bass

bar lies almost under the fourth string, while the sound-post stands near that foot of the bridge which is under the first string. In the work on the violin assistance was received from Messrs. T. J. Richmond, T. F. Ebblewhite, and W. B. Kilby. A number of vibration-curves obtained for the violin were shown on the screen. Fig. 5 gives one set of these, showing the vibrations of each string as indicated by the letters

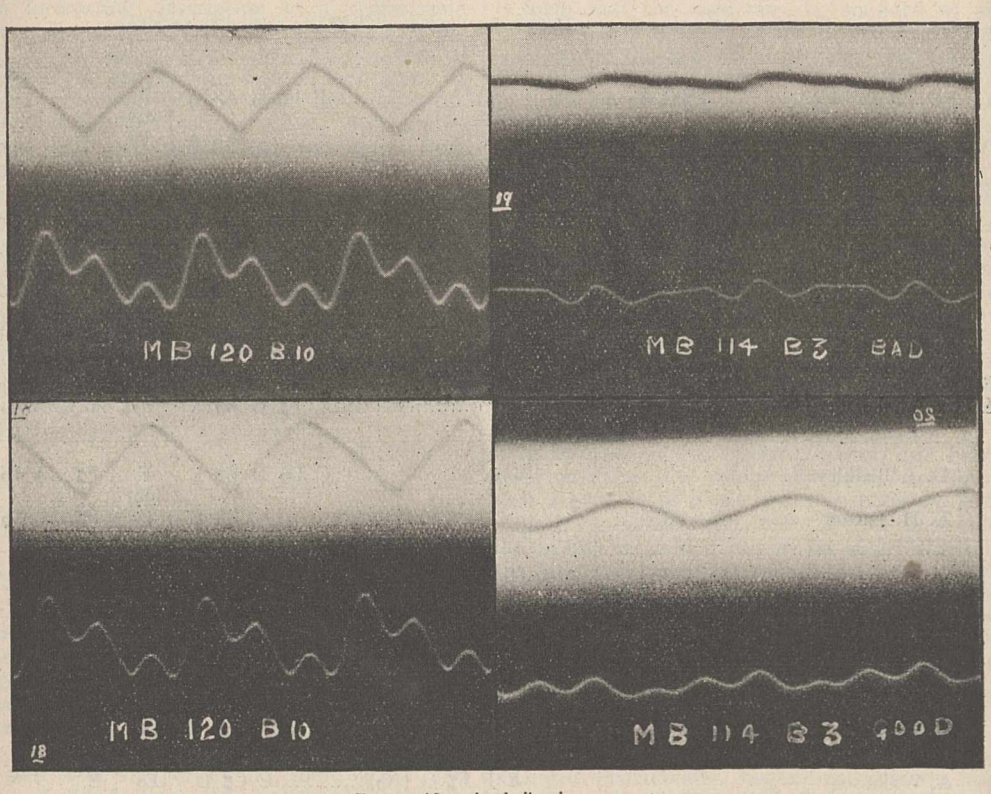

FIG. 4.—Monochord vibration curves.

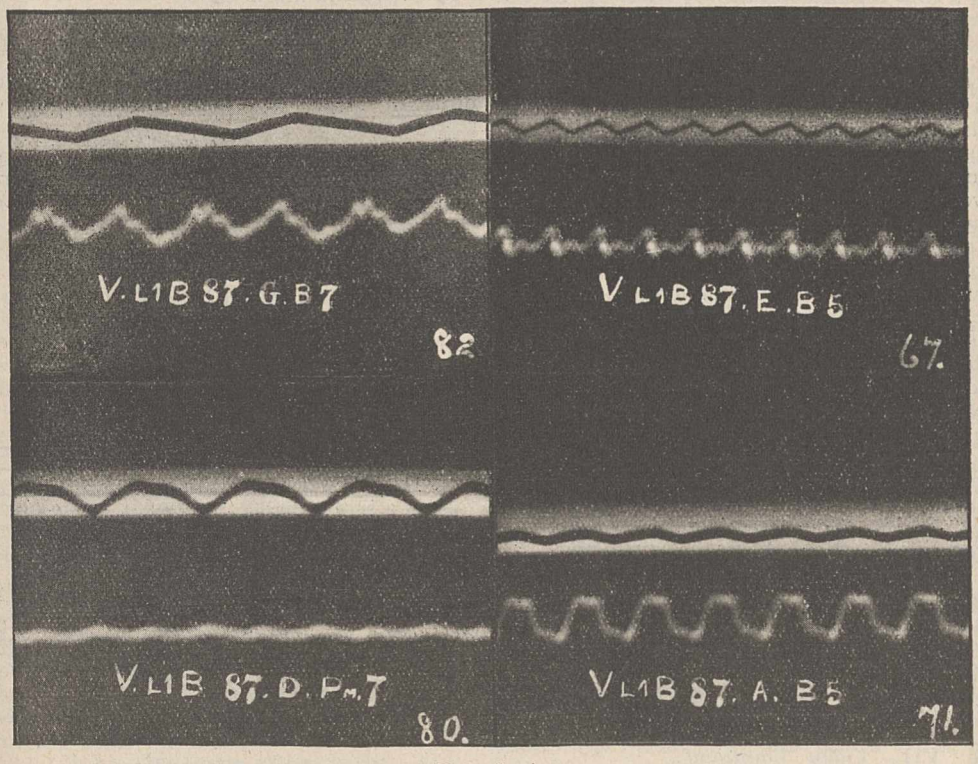

FIG. 5.—Violin vibration curves.

G, D, A, and E. The D string was plucked by a sharp point, the other strings were bowed. The white line shows the longitudinal motions of that corner of the bridge near which the first or E string passes.

VIII.—*Conclusion.*

With respect to the sympathetic vibrations occurring in stringed instruments, it is obvious that, though some little has been done, much more remains awaiting attack. Thus the violoncello, guitar, and harp might be dealt with, but especially, because of its immense vogue, the pianoforte needs thorough investigation. A start was made some time ago by Mr. G. H. Berry, and further researches are now in progress in London under the joint direction of men of science and piano manufacturers.

In the past music-lovers and men of science alike have been deeply indebted to the makers of musical instruments, who have themselves received but little help from science in return. The lecturer expressed the hope that science might shortly pay off part of its debt to the musical craftsmen of the country, and help to make the British piano second to none in the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Moxon medal of the Royal College of Physicians of London has been awarded to Dr. F. W. Mott. The Weber-Parkes prize is not to be awarded this year.

A VOCATIONAL Training Bill carrying an appropriation of 400,000*l.* has been passed by the U.S. Congress. It provides for a system of training for soldiers in more than three hundred trades.

A COMMITTEE has been appointed to inquire and report as to any improvements which may appear desirable to be made in the conditions of service and in the methods of remuneration of teachers in intermediate schools in Ireland, and in the distribution of the grants made from public funds for intermediate education, and as to the best means in the public interest of effecting such improvements. The members of the Committee are:—The Rt. Hon. T. F. Molony (chairman), the Lord Chief Justice of Ireland, the Rt. Hon. W. J. M. Starkie, Sir J. Larmor, the Rev. P. Canon Marshall, the Rev. T. Corcoran, the Rev. Brother Hennessy, Prof. J. M. Henry, Prof. R. M. Henry, Mr. J. Thompson, Miss H. M. White, Miss M. Ryan, Mr. W. J. Williams, Mr. C. R. Beavan, Miss A. McHugh, Miss E. Steele, Mr. G. Fletcher, Mr. E. Ensor, and Mr. M. Headlam.

THE governing body of Birkbeck College has appointed Dr. George Senter to the office of principal recently vacated by Dr. George Armitage-Smith, who had filled the position for more than twenty years. Dr. Senter, who is well known for his research and writings in chemistry, is head of the chemistry department of the college. Formerly he held the readership in chemistry at St. Mary's Hospital Medical School, and, in addition to important examining and tutorial posts in London University, held a seat on the University Senate. His election comes at an interesting time in the long and eventful history of the college, which, familiar to many thousands as a pioneer in public education, has continuously developed the scope and nature of its activities under Dr. Armitage-Smith, and has been recognised by Royal Commission as the future centre of evening university work in London.

THE report just received of the conference of representatives of provincial museums held at Sheffield on October 16–17, which dealt with the educational value of museums and the formation of war-museums, contains interesting accounts of what is being done in Manchester and other towns to bring the museums into closer relation with the schools, but beyond affording evidence of a desire on the part of museum authorities to depart from their traditionally passive attitude, the discussion shows little sign of any attempt to grapple with the principles upon which successful effort in this direction must be based. Neither circulating collections of museum objects nor organised visits to museums as such solve the educational problem. They often mean nothing better than a more elaborate form of the old-fashioned object-lesson, which is discredited because it commonly touches no vital interest. Reaction against verbalism may easily plunge us into another kind of abstract teaching, which is none the less abstract because it is based on things present to the senses. It is only when contact with an object is revealing, when it illuminates a dark place in our minds or opens up an aspect of the world hitherto unrealised, that it is, rightly speaking, educative. We may use it to give information, of course, but information has in itself slight educational value. From this point of view Mr. Haward's account of his work at the Manchester Art Gallery is the most valuable contribution to the subject. He has in mind a revelation, and, even though the children may not feel the ultimate message he would convey to them, it is precisely the ultimate message which should determine the whole procedure. This is true also of similar work in the museum, and a future conference might well address itself to the problem of this final outcome, for it is in the light of that we may hope to discuss profitably particular proposals and particular practice.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Irish Academy, June 24.—The Most Rev. J. H. Bernard, D.D., Archbishop of Dublin, president, in the chair.—H. **Ryan** and W. **O'Riordan**: α-, β-, and γ-trinitrotoluenes. An attempt was made to ascertain whether differences in the reactivities of the trinitrotoluenes exist which might explain the instability of trinitrotoluene in some rare cases. The behaviour of the three isomers towards alkalis, alkyloxides, amines, hydrocarbons, and aldehydes was examined. All three isomers yield black, amorphous, explosive bodies when heated with alkalis. The β- and γ-isomers have each one nitro-group replaced by a hydroxyl, giving dinitrocresols. The α-isomer yields hexanitrodibenzyl. The β- and γ-isomers readily exchange a nitro-group for an amino-group, the β-isomer being apparently the more reactive. The α-isomer forms additive compounds, without substitution, by interaction with amines. The additive compounds obtained from the γ-isomer and amines readily pass into substitution derivatives. Towards hydrocarbons such as phenanthrene the three isomers behave similarly. While α-trinitrotoluene interacts readily with aldehydes, forming stilbene derivatives, the latter could not be obtained under similar conditions from the β- and γ-isomers.

PARIS.

Academy of Sciences, July 16.—M. Léon Guignard in the chair.—G. **Bigourdan**: The observatory of the Hôtel of Taranne: works and co-ordinates. This observatory was founded about 1710 by Louville, who was the first to use a filar micrometer in astronomy,

and measured the variation of the obliquity of the ecliptic. The exact position of the observatory is given.—P. **Termier**: The eruptive rocks interstratified in the Coal Measures of Littry (Calvados): the magnitude, variety, and duration of the volcanic manifestations in the Littry region during the Stephanian period. Two borings for coal have been recently made at Saint-Martin-de-Blagny and at Poterie. Although coal was not found, these borings have given valuable information on the constitution of the coal-bearing layers and on the nature of the volcanic eruptions mixed with the sedimentary deposits.—C. **Richet**, P. **Brodin**, and Fr. **Saint-Girons**: New observations on the effects of intravenous saline transfusions after grave hæmorrhage. A description of experiments on dogs, in continuation of work published in earlier communications.—M. **de Sparre**: The advantages resulting from the use of a contraction at the entrance to reservoirs designed to attenuate hammering in pipes.—E. **Ariès**: The pressures of saturated vapour of octatomic bodies. The formulæ developed in earlier papers is applied to the experimental data on methyl formate, ethyl bromide, ethyl chloride, acetic acid, and ethane. Modifications in the values for the critical pressures and temperatures of ethyl chloride are required to bring the experimental and calculated values into agreement.—E. **Vessiot**: The trigonometrical developments of celestial mechanics.—Ed. **Chauvenet** and Mlle. H. **Gueylard**: The combinations of acid zirconyl sulphate with some alkaline sulphates. The existence of compounds of ammonium and sodium sulphate with acid zirconyl sulphate has been proved by thermochemical and cryoscopic measurements.—P. **Duret**: A new method for the rapid destruction of organic materials. The method is based on the oxidation by ammonium persulphate in sulphuric acid solution. The application of the method to the examination of urine for traces of arsenic is given in detail.—G. **Nicolas**: Anthocyanine and the respiratory gas exchange of leaves. A relation has been proved between the formation of the anthocyanic colouring matter and respiratory oxidation.—F. **Ladreyt**: The functional evolution of certain conjunctive elements.—C. **Cépède**: New means for the prognosis of pulmonary tuberculosis. The method is based on Arneth's figure from hæmatological data.—H. **Vincent** and G. **Stodel**: A preventive and curative serum for gas gangrene. The serum is obtained by injecting into the horse multiple bacterial races, including the principal anaerobic species causing gas gangrene. The protective action of the serum on guinea-pigs has been proved, and application to man has also been successful.

BOOKS RECEIVED.

National Reconstruction. By J. J. Robinson. Pp. viii+154. (London: Hurst and Blackett, Ltd.) 2*s*. 6*d*. net.

A Monograph of the Pheasants. By W. Beebe. In four volumes. Vol. i. Pp. xlix+198+coloured plates xx+photos 15+maps 5. (London: Witherby and Co.) 12*l*. 10*s*.

An Elementary Treatise on Curve Tracing. By Dr. P. Frost. Fourth edition revised by Dr. R. J. T. Bell. Pp. xvi+210. (London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

Canning and Bottling. By H. Pixell Goodrich. Pp. x+70. (London: Longmans and Co.) 2*s*. net.

Plant Genetics. By J. M. and M. C. Coulter. Pp. ix+214. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.) 1.50 dollars net.

The Twin Ideals: An Educated Commonwealth. By Dr. J. W. Barrett. Vol. i. Pp. xxxii+512. Vol. ii. Pp. xx+504. (London: H. K. Lewis and Co., Ltd.) 2 vols., 25*s*. net.

Treatise on Applied Analytical Chemistry. By Prof. V. Villavecchia and others. Translated by T. H. Pope. Vol. ii. Pp. xv+536. (London: J. and A. Churchill.) 25*s*. net.

Coal and its Scientific Uses. By Prof. W. A. Bone. Pp. xv+491. (London: Longmans and Co.) 21*s*. net.

Elements of the Electromagnetic Theory of Light. By Dr. L. Silberstein. Pp. vii+48. (London: Longmans and Co.) 3*s*. 6*d*. net.

The Stars and How to Identify Them. By E. W. Maunder. Pp. 63. (London: C. H. Kelly.)

Common British Beetles and Spiders and How to Identify Them. By S. N. Sedgwick. Pp. 62. (London: C. H. Kelly.)

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