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London University Site.

THE public must be getting puzzled and bewildered over the question of the site for the University of London. Until recently it believed that the site at Bloomsbury had been definitely decided upon, and it expected that active preparations would shortly be made for the erection of buildings. There were good reasons for the belief and for the expectation. A public announcement was made that the Government's offer had been accepted, and that the purchase of the site had been completed. A few months later a temporary but very substantial building, provided by an anonymous donor at a cost of 20,000*l*., for the University Institute of Historical Research, was actually erected on the Bloomsbury site and formally opened by the President of the Board of Education. This certainly looked as if the innumerable discussions and delays had at last resulted in something like definite action.

Before the summer vacation, however, the whole question was re-opened by the London County Council, which invited the Board of Education and the university to "explore the possibilities" of a site on the Holland Park estate before taking further action on the Bloomsbury site. The Council's resolution refers to the Holland Park site as "easily accessible from all parts of London, costing much less money, very much larger in area, and so affording room for expansion."

Any opinion expressed by the London County Council as the authority charged by Parliament with the promotion of higher education in London is entitled to be received with respectful consideration. It is difficult, however, to see what action the senate of the university can take. Before accepting the Government's offer of the Bloomsbury site the senate consulted the Council and was assured that in the event of the site being accepted the Council would consider making a building grant up to a third of a million pounds. Fortified with this expression of approval, the senate accepted the offer, and the sale was completed. It is impossible to withhold sympathy from a university which, having had one very valuable site presented to it, and having already partly acquired possession of it, is invited to "explore the possibilities" of another site which no one has offered to give. *Beati possidentes*: a non-academic body would have a ready answer, but it will probably be found that the senate of a university is not utterly lacking in worldly wisdom.

The fact that the Bloomsbury site has been accepted and is partially occupied is not of itself decisive. If a blunder has been made, it should be rectified. It is quite conceivable that there are better sites than that at Bloomsbury, but it is quite certain that Holland Park is not such an one, however diligently its possibilities are explored. The extent to which it is "easily accessible from all parts of London" may be seen by a moment's reference to a map. That it costs "much less money" is quite probable: it would probably cost even less if it were somewhat nearer than it is to Hammersmith and Shepherd's Bush. If this is the only serious alternative to the Bloomsbury site, there can be no doubt as to the result of exploring its possibilities, and time spent in doing so would be time wasted.

Too much time has, in our view, been wasted already. The need for a dignified home for the university is urgent and clamant.

It will not be met by suggestions to explore the possibilities of pleasant parks which happen to be without a building. The site must be central; it must be within easy reach of the great colleges and medical schools where the great bulk of the teaching is carried on; and it must be accessible to the hundreds of teachers and others who participate in the work of the university and the thousands of students who go up for its examinations. Up to the present the Bloomsbury site is the one that best complies with these requirements, and if it were not already "signed, sealed, and delivered," there are sufficient reasons why it should be.

Travel in North-west China.

Travels of a Consular Officer in North-west China. By Eric Teichman. Pp. xiv+219+58 plates. (Cambridge: At the University Press, 1921.) 25*s*. net.

Shensi and Kansu, in the remote north-western corner of China, are comparatively little known, for neither province has any railway or any town open to European trade. They are so far within Asia that they suffer from an arid climate and include large areas of typical loess land while they are traversed by the Ch'inling Mountains, the main mountain axis of Central China, which rise from the lower Hoang Ho to the Mongolian plateau. They range, therefore, from fertile lowlands to a high tableland, where the only extensive trade is in wool, with some alluvial gold-mining in deposits which the author's statements represent as comparatively rich.

Mr. Eric Teichman, of the British Consular Service, who is well known from his explorations in South-western China, made a tour of 4000 miles through the two provinces in 1917 in connection with the Opium Treaty. The conditions of travel were unusually favourable, as he had the privileges of a Chinese official, and he has used his opportunity to prepare two useful maps based on compass surveys, and to collect much valuable information as to the state of North-western China during a critical period. The author's remark, at the conclusion of the narrative of his journeys, that "the reader . . . is probably as tired of reading about them as the writer is of recording their description," indicates that the book is not light in style; but to those interested in China it contains much instructive information, and the chapters on the missionaries and on projected railways will interest a wider public.

The author's routes crossed both provinces in various directions, and extended to Chengtu, the capital of Szechuan, to the south-west. He returned by raft down the Hoang Ho. The most important contributions to science are in reference to loess and oil. The author's conclusions as to the formation of loess are unorthodox. He had excellent opportunities for studying it, and he rejects the theory of its formation by wind-borne dust. "The longer we travelled in the loess country," he says, "the more difficult it seemed to credit this theory." He attributes it to floods, and considers that its composition and distribution are in favour of an aqueous origin. The absence of fresh-water shells he dismisses as of no significance, since they are equally absent from loess which has certainly been re-deposited in water.

The author gives a brief but interesting account of the effort of the American Standard Oil Co., in accordance with a wide-reaching concession granted them in 1914, to develop an oil-field around Yenchang in northern Shensi. Two wells had been sunk there by Japanese, and they are still flowing and producing a considerable supply, which is used among other purposes as flares on the city walls in order to scare off brigands. The Standard Oil Co., after a promising preliminary report by its experts, made numerous bores, but found no further oil, and abandoned the concession in 1916.

Mr. Teichman's observations are most authoritative on the political condition of the country, on the projected railways, for which concessions have been granted to Belgian, Franco-Belgian, and American syndicates, and on the opium industry. He traversed the country when the recrudescence of opium-growing after the revolution of 1911 had been suppressed; but the preface reports that since his journey, in spite of the efforts of the Government, the cultivation of the poppy has again become widespread in Western China.

North-western China has a large Moslem population, due to two immigrations, the later of which occurred five or six centuries ago. The descendants of that movement are racially distinct, but those of the earlier colony are now physically Chinese. The author speaks highly of the influence of Islam, and regards the Moslem as superior to the adjacent Chinese. Though they are a minority of the population, they are so strong and so wisely led that they are allowed practically to govern themselves. Islam has inspired a native self-supporting sect, and the author holds it up as an example in that respect to the Christian missions. He expresses high praise for the secular and educational work of the Protestant missions, but of their religious work and sectarian jealousies, and of the political organisation of the Catholic missions, he is severely critical.

China is at present the prey to internal discord and civil war, and the author speaks of large areas being abandoned to sand and brigands. Shensi was devastated by the secret society of "White Wolves" in 1914, and has been the battleground between the northern and southern armies; but the author's numerous references to former civil wars and rebellions, and to the extension of trade and production, despite the present political feuds, justify the faith that the resources of China, and the magnificent industry and intelligence of the Chinese, will enable the country once again to overcome difficulties that would be fatal to any State with a less stable economic foundation.

The book is illustrated by a series of excellent photographs. J. W. G.

Natural History of Pheasants.

A Monograph of the Pheasants. By William Beebe. (In four volumes.) Vol. 2. Pp. xv+269+plates. (London: H. F. and G. Witherby, 1921.) 12*l.* 10*s.*

THE first volume of this sumptuous and important work was noticed in NATURE for December 19, 1918, p. 302, and the long interval between its appearance and the issuing of the second instalment has been, the publishers point out, unavoidable, owing to various circumstances associated with the war.

The present volume treats of twenty-two species and of the hybrid forms of some of them: of the Kaleeges (genus Gennæus), of which there are ten species; the crestless firebacks (genus Acomus), two species; the crested firebacks (genus Lophura), four species; the white-tailed wattled pheasant (genus Lobiophasis), one species; and the junglefowls (genus Gallus), five species. All these genera are peculiar to the fauna of the Oriental regions. The life-histories and habits of a number of these birds were previously little or altogether unknown, owing to the difficulty of penetrating the dense jungles and forests which form their native haunts.

For many reasons the author considers the Kaleeges the most interesting members of the pheasant family, especially so on account of the very puzzling nature of the many forms, of which no fewer than thirty-five have been described either as species or as subspecies. Mr. Beebe has carefully studied these forms, with the result that he recognises only nine as full species, and the remaining twenty-six as natural hybrids. In Burma, where the range of three species (*Gennaeus lineatus, G. horsfieldi,* and *G. nycthemerus*) is conterminous, an astounding amount of hybridisation takes place. His researches have also added much to the knowledge of the home-life of several of the species. In like manner ornithology is indebted to him for his contributions to the histories of the crestless firebacks which inhabit the low-lying jungles of the Malay Peninsula and Sumatra, these in some cases being revealed only after great difficulties had been encountered. The same may be said of certain species of the crested firebacks, especially the Malayan species (*Lophura rufa*), a glimpse of the beauty of which, he tells us, was worth the longest stalk and the most wearisome wait. He was also successful in meeting with the gorgeous white-tailed wattled pheasant amid the upland jungles and low forests of Central Borneo. Regarding this species, Mr. Beebe rejoices that it has only one synonymic name, remarking that it is "a most welcome simplicity in nomenclature after such unfortunate taxonomic tangles as surround the specific identity of the species of Lophura." In this connection it may be noted that he has not made use of a single trinomial name in his great work.

The volume concludes with an account of the species of junglefowl, the typical form of which, *Gallus gallus,* the red junglefowl, is the parent stock of all the domestic breeds of poultry, and hence "to the human race . . . the most important bird on earth." This species is a native of India, Burma, Siam, Gambodia, the Malay States, and Sumatra, and is found in the wildest regions, as well as in close proximity to the wildest native villages. Through human agency it is now to be found in a more or less feral state in islands so far removed from its native haunts as Tahiti, but remains attributed to a species of Gallus have been discovered in deposits of Pleistocene age in New Zealand, while others of Pliocene age have been obtained in France and in Greece. If the identification of these fossil relics—not alluded to by Mr. Beebe—is to be relied upon, it is evident that junglefowls had a much wider range in prehistoric times. The Ceylon species (*G. lafayetti*) and the grey junglefowl (*G. sonnerati*) do not call for special mention. Perhaps the latter bird is best known on account of the fact that the terminal portion of its neck hackles are an almost indispensable adjunct to the modern salmon fly. With the fine and hitherto little-known Javan species it is otherwise, for there are some important facts associated with its geographical distribution, since it is the only species of the pheasant family treated of by the author the home of which is entirely confined to islands south of the equator. Moreover, it may be remarked, it is the only form the range of which extends into the Austro-Malay region, for it is a native of the islands of Lombok, Sumbawa, Flores, and Alor.

There have been many monographs devoted to various groups of birds, including the pheasants, not a few of which rank among the most beautiful works devoted to any branch of zoological science, but it is not too much to aver that the book under notice is incomparably the best. It may have been approached in the beauty of its bird-portraiture, but its unrivalled merits are due to the original descriptions of the birds in their native surroundings, written by one who is intensely imbued with an all-round love of Nature, and endowed with a graceful pen—a combination which has imparted a fascination to the graphic descriptions of experiences in many cases unique. A number of the haunts were reached only after extraordinary difficulties had been overcome by the author's indomitable perseverance, and in the company of savages, some of whom were only "nominally safe." Thus were the facts respecting the home-life of certain little-known or wholly unknown species obtained, and the photographs of their abodes, which have been beautifully reproduced in photogravure, secured. The coloured plates, twenty-four in number, are excellent, especially those by Mr. G. E. Lodge and Mr. Grönvold, while a series of maps illustrating the distribution of the various species adds to the worth of a valuable and noteworthy contribution to ornithological literature. W. E. C.

Bütschli's Lectures on Comparative Anatomy.

Vorlesungen über vergleichende Anatomie. By Prof. Otto Bütschli. 3 Lieferung: *Sinnesorgane und Leuchtorgane.* Pp. iii+643–931+xiv. (Berlin: Julius Springer, 1921.) 48 marks.

THE first two parts of this text-book have already been reviewed in NATURE (in 1911, July 27, p. 104; and 1913, August 7, p. 577), and the distinctive merits of the work have been indicated. In the third part the excellence of the semi-diagrammatic illustrations and the lucidity of the exposition are fully maintained, although the author died in 1917, leaving the work unfinished. The difficult task of completing the work for this volume and seeing it through the press has been achieved with conspicuous success by Drs. Blochmann and Clara Hamburger.

The work deals with the sense-organs and the light-emitting mechanisms of both invertebrate and vertebrate animals, and, as in the preceding volumes, each structure is considered from a broad, comparative point of view, and illustrated with a wealth of diagrams. The reader can thus acquire easily a clear conception of the varied forms assumed throughout the animal kingdom by the series of sensory organs in the skin, the peripheral instruments of smell and taste, and the organs of equilibration, hearing, vision, and light-production. This method of treatment is of special interest and importance to the vertebrate morphologist. The latter experiences an increasing difficulty in discovering what is known about invertebrate anatomy, some of which often becomes of crucial importance in his researches. These considerations apply with special force to the sense-organs, and especially to those of vision, the understanding of the structure of which in invertebrate animals is essential for the adequate appreciation of the nature of the nervous arrangements in the eyes of vertebrates. The vast significance of the evolution of the sense-organs and their nervous connections with the evolution of vertebrate animals gives an additional interest to the text, supplemented as it is by the fascinating series of diagrams, which have been admirably chosen and clearly reproduced.

It is unfortunate that the authors, who must have sifted a vast array of writings in collecting the material for this volume, have omitted all bibliographical references, the inclusion of which would have trebled the value of the work. This is particularly to be regretted in the case of the light-emitting organs, for it is difficult for those who become interested in the elusive physico-chemical problems of these remarkable structures to get on to the track of the biological literature relating to them. G. ELLIOT SMITH.

Earth-structure.

Der Bau der Erde. By Prof. Leopold Kober. Pp. iv+324+2 plates. (Berlin: Gebrüder Borntraeger, 1921.) 80 marks.

THIS handsomely printed work, with a frontispiece, a folded map of general earth-structure, and line-illustrations in the text, is, in spite of its nominal price, a welcome sign of scientific recovery. The absence of an index is surely an accident which its well-known publishers will redress. Perhaps the most striking feature, and one that will encourage general use, is its crisp lucidity of style. We have selected at random ten consecutive sentences. They contain a total of 133 words, and one consists of six words only. This shows the German-Austrian language at its best, and we should like to attend Prof. Kober's lectures. His main thesis is that the building of folded mountain-chains is a process of "revolution" following on one of "evolution," in which geosynclinals have been formed. A geosynclinal represents what we sometimes regard as an epoch of quiescence. Its sinking base ultimately becomes nipped between two rigid masses of the lower crust, and the sedimentary accumulation rises in folds and overfolds at the surface. Mountain-building is the close of a cycle, and is a manifestation of the continuous contraction of the substance of the earth. A mountain-range denotes a lateral shrinkage of the outer crust. The portion of the earth that includes the geosynclinal masses and the resulting mountains is styled the "orogen"; the old and consolidated blocks are styled the "kratogen"—presumably because they exercise force upon the yielding orogen. All crust-disturbances originate in centripetal downward movement.

The immense part played by a forward movement that is largely gravitational is well shown in the treatment of the Alpine chains. Prof. Kober opposes the views of Suess as to the relationship of a general southward movement in Asia to a northward movement (a Rückfaltung) in Europe, and he urges that in both continents southerly and northerly thrusting may be traced. He introduces a number of useful conceptions. In the apparent absence of Mesozoic marine sediments round the Atlantic border he sees evidence of their recent submergence beneath the ocean. Africa is considered to be a vast block compressed within a ring provided by the Alpine orogen. Prof. Kober's treatise includes his own observations in the unfamiliar field of Syria, and his broad outlook maintains the tradition of the school inspired by Suess. Suess, continually revising his views in the light of later knowledge, raised more problems than even his long life could solve. We are still far from picturing earth-structure as bound by symmetry and rule.

GRENVILLE A. J. COLE.

Our Bookshelf.

Tychonis Brahe Opera Omnia. Tomi Quinti Fasciculus Prior: Astronomiae Instauratae Mechanica (1598); *In Solis et Lunae Motus Restitutos ac Sequens Diarium Prolegomena* (1598); *Specimen Diarii Anni* 1599 (1598); *Ephemerides Solis Annorum* 1586-1592. Pp. 213. (København: Gyldendalske Boghandel, 1921.)

IN this volume, or rather in this fasciculus, we are given some of the most interesting if not the most important works of Tycho Brahe. The title-page of the volume with the editor's name appears to be reserved for the second fasciculus, but it is probably safe to conjecture that the new volume, like its predecessors, has been produced by Dr. Dreyer. The first of these works was printed at Tycho Brahe's press at Wandsbek in the duchy of Holstein-Gottorp, where he was the guest of Heinrich of Rantzau. Thither he had transported his observations and most of his instruments in consequence of a disagreement with King Christian IV. which had led him to leave Denmark. He was now seeking a new patron, and his eyes turned to the Emperor Rudolf II., to whom this work is dedicated. It is in effect an attempt—as it happened, a successful attempt—on the part of the author to commend himself and his work to the emperor, and it contains an illustrated account of the structure and use of each of his instruments, an autobiography with an account of his achievements and projects, and an appendix describing his observatory at Hveen. The remaining works are now printed for the first time. The most important of them is the *Prolegomena*, which occupies twenty-five pages and treats generally the importance of the sun and moon in the universe and the corrections which the author has introduced into their theory.

On the whole it may be said that while these works do not contain any discovery which is not more fully treated elsewhere, they give us as good a conspectus as we could desire of his powers and achievements as an astronomer, and in the main his own judgment of his work is confirmed by the subsequent progress of science. His chief distinction lies in his genius in devising and his industry and ingenuity in using astronomical instruments, in which he stands immeasurably above all his predecessors. In his revision of constants and of theory he shows no genius, but a capacity which entitles him to rank next, perhaps, to Hipparchus and Copernicus. We shall doubtless be able to estimate his work better when the second fasciculus appears with the editor's notes.

J. K. F.

Icones Plantarum Formosanarum necnon et Contributiones ad Floram Formosanam. By Bunzō Hayata, Rigakuhakushi. Vol. 10. Pp. iv+335. (Taihoku: Bureau of Productive Industries, Government of Formosa, 1921.)

DR. HAYATA has devoted twenty years to the study of the vegetation of the island of Formosa, which, lying directly under the tropic of Cancer, and possessing mountain ranges rising more than 10,000 ft. above sea-level, presents almost every kind of climatal and topographical feature, with an extraordinarily rich flora embracing tropical, temperate, and even alpine elements. Climatic conditions and the activity of the head-hunters of the interior had restricted exploration to the coastal regions before the acquisition of the island by Japan. Dr. A. Henry's "List of Plants from Formosa" (1896), the first attempt to outline the flora, included 1428 species. This number has been nearly trebled by Dr. Hayata's efforts since his first visit to the island in 1900, and by later visits, as well as by his elaboration of collections made by other botanists. The present volume, the last of the series, includes an index to the ten volumes, comprising 3658 species of flowering plants and ferns, representing 1197 genera and 170 families. More than 1200 species are new, and among the new genera is the remarkable conifer, Taiwania. The volumes are profusely illustrated and form a very valuable contribution to the taxonomic study of an area of special interest.

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Letters to the Editor.

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

The Development of Optical Industries.

WE are asked by our principals, Messrs. Carl Zeiss, of Jena, to transmit the following observations on the leading article, "The Promotion of Our Optical Industries," which appeared in NATURE of February 10 last (vol. 106, p. 749), with the request that you would kindly extend to them in your columns the publicity which the importance of the subject deserves. It is regrettable that so long an interval should have been permitted to elapse, but we understand that the head of the department at Jena which deals with Press matters was absent from headquarters for several months :—

"To the leading article, 'The Promotion of Our Optical Industries,' which appeared in NATURE of February 10 last, some remarks present themselves which call into question the position assumed by the British Optical Instrument Manufacturers' Association. The article also contains some statements which are erroneous and call for correction.

"It would seem that the writer of this article was not perfectly acquainted with the history of English glass manufacture, for the words 'supremacy in the optical glass industry, which was established in this country as early as 1837,' are scarcely supported by an historical investigation. Such a supremacy did not then exist in England. It may perhaps be worth while to furnish some trustworthy historical data.

"When between 1825 and 1829 experiments on a very large scale were made in England, of which the Bakerian lecture given by Faraday at the end of 1829 was a detailed account, the position of English glass manufacture was not very flourishing, nor were the glasses of Benedictbeurn, near Munich, or those of les Brenets, in Neuchâtel, at that time obtainable in England. It would seem that even Faraday's energy was unable materially to alter that state of things, for his 'heavy glasses' were never largely employed for optical instruments in general. G. Bontemps's opinion that Faraday's experiments were discontinued, because later on ordinary optical glass was obtainable in France and in Switzerland, may possibly be correct. W. V. Harcourt's early experiments between 1834 and 1844 are very imperfectly known, but the result at that time was scarcely of any practical importance. G. G. Stokes, in any case, did not think much of the first specimens Harcourt sent in during 1862, and he attributed—very justly, one may think—a great part of the later remarkable scientific achievements (themselves without great practical value) to their united endeavours between 1862 and 1871. But these are matters of a much later period; we may, however, turn to the testimony of an English eyewitness of 1849, the telescope manufacturer, W. Simms, on the former state of English flint-glass manufacture. From his description we cannot infer anything of that English 'supremacy as early as 1837,' but must conclude that in England flint-glass for optical purposes had not been made commercially before the necessary technical knowledge was imported from France, when G. Bontemps came over to Chance's factory after 1848. After that time ordinary crown glass and ordinary flint-glass of good quality were put on the market in France, in Switzerland (by Th. Daguet in Solothurn up to the time of his death in 1870), and in England, the Munich factory working only for its proprietor, the optician Merz.

"This state of things was difficult to alter, as these few factories in thus practically monopolising the glass trade had no interest in making costly experiments for new kinds of glass for which no ready sale could be warranted. It was left to the man of science who demanded glasses with new properties to carry out the melting, and Abbe's and Schott's history shows how difficult it was to make the necessary scientific investigations. In order to facilitate industrial manufacture, the Prussian Government in 1883 contributed the sum of 60 000 marks (3000*l.*), whereas, according to Payen, the cost of Faraday's experiments had been 150,000 francs, equivalent to 6000*l.*, or even more if regard be paid to the then (1830) higher purchasing power of money. *Apart from that sum of 3000l. no State subsidy has ever been paid to the Jena glass factory,* nor was there any necessity for any further subsidy, for even the *optical* branch of the Jena glass factory of Schott und Gen. was financially successful. The idea that the manufacture of optical glass is impossible on a commercial basis finds further refutation in the fact that in 1893–94 Ch. E. Mantois, of Paris, began to melt the new kinds of glass for commercial purposes, and that a new German optical glass factory, Sendlinger optische Glaswerke G.m.b.H., was founded in 1913.

"Summing up the results, it is clear that English men of science of the highest standing were at work, and at least one of them—Faraday—was liberally assisted by the Government. That the success achieved did not come up to expectations may be attributed to the lack of a close and efficient co-operation such as existed between Abbe and Schott, which cannot be guaranteed by the cleverest institution.

"Another point in the article may well be questioned: 'If the British optical instrument industry is to be maintained and to develop so as to turn out products equal at least to the best products of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply, equal, again, at least to the best available anywhere.'

"History does not point to the existence of such a very close relation between the welfare of the glass founder and of the optical instrument maker in the same country. Let us take, for instance, the history of the photographic objective, and this because we have here a modern instrument the history of which is sufficiently well known. The earliest (1840) invention of the first order belongs to Petzval, a mathematician in Vienna, who had to use French glass; a second invention, though devoid of commercial success (1843), belongs to the American engineer, A. S. Wolcott, who likewise had only French glass at his disposal. He was the first to publish a remarkable theory of the symmetrical lens, but it cannot be said that his discovery would have been improved by his having at his disposal raw material from an American factory. A. Steinheil bringing out his different series of aplanats and antiplanats between 1866 and 1881 may well be cited as an optician who was especially successful in his use of readily procurable foreign (French and English) glass. And when, finally, we arrive at the period of Jena glasses, we may point out that, apart from Zeiss's assistants, scientific men of no connection with Schott's factory, like E. von Hoëgh, A. Kerber, R. Steinheil, D. Kaempfer, etc., had to take the glasses from Schott as offered.

Amongst these a very important place must be reserved for H. Dennis Taylor, who constructed the very simple and very efficient type of the triplet, 'the Cooke lens,' or better 'lenses,' of the foreign material willingly placed at his disposal.

"Great opticians like Fraunhofer and Abbe were undoubtedly wanted in order to show to the incredulous optical world the necessity for new glasses by means of which different optical instruments could be brought to much higher efficiency; this feat having once been accomplished, the interest of the manufacturing optician and the glass founder are not nearly so closely connected as the writer of the article would appear to believe. We call to mind two characteristic instances where a founder, by pushing his own advantage too far, materially damaged the optician. In Munich, as was mentioned earlier, the optician Merz was proprietor also of the glassworks; his short-sighted exclusion of competitive opticians from the output of this factory was the real cause of the death from inanition of the oldest glass factory founded by Guinand and improved by Fraunhofer. On the other hand, the practical monopolisation of the glass market by French and English houses between 1848 and 1883 was certainly convenient from the founder's point of view, but it materially hampered the progress of the optical engineer. In the long run this shortsighted policy could not, however, prevent the establishing of more progressive glass manufactories, and this competition was undoubtedly in the interest of the optical manufacturer, although the old factories, showing less scientific initiative, suffered by it. The German optician certainly profited by this competition, but he did so in common with the foreign optician, whether American, Austrian, English, French, Italian, or Swiss.

"We do not hesitate to state that optical mathematicians of all countries will hail with strong approval every extension of the choice of glasses at their disposal, and deplore their exclusion—be the reason whatever it may—from any valuable material available to opticians in foreign countries."

J. W. Atha and Co.
(A. F. Degenhardt.)

8 Southampton Row, London, W.C.1,
August 4.

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The observations of Messrs. Carl Zeiss, of Jena, challenge the article, "The Promotion of Our Optical Industries," published in Nature of February 10 last on three points:—(1) They deny what the article asserted, that supremacy in the optical glass industry passed over from this country to Germany, on the grounds that England never held supremacy in this industry. (2) They deny that State subsidies were made continuously to the optical glass industry in Germany from the time of the investigations of Schott and Abbe in 1881 down to the declaration of war in 1914; and they state categorically that, apart from a sum of 3000*l.* contributed by the Prussian Government in 1883, no State subsidy has ever been paid to the Jena glass factory. (3) They dispute the proposition that "if the British optical instrument industry is to be maintained and to develop so as to turn out products equal, at least, to the best production of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply equal, again, at least to the best available anywhere."

(1) As to the first point, the "trustworthy historical data" supplied by Messrs. Carl Zeiss are incomplete and inconclusive. The article in Nature did not assert that "supremacy" was established as early as 1837, but that the optical glass industry was established in this country in that year. The supremacy came later. It was not until 1848, when Bontemps left Choisy and came to Messrs. Chance's works, that Messrs. Chance Brothers were able to surmount the difficulties which surrounded the manufacture of optical glass. Such progress was afterwards made with the production of large meltings of uniform optical glass that the English firm quickly gained a very high reputation for the manufacture of large discs of optical glass of the finest quality for astronomical work. A few instances may be mentioned of their successful production of large telescope discs, that most severe test of the skill of the optical glass manufacturer.

At the Great Exhibition of 1851 the firm showed a 20-in. disc of light flint "for daguerreotype apparatus" and a 29-in. disc of dense flint, weighing 200 lb., for which a Council medal was awarded. In 1855 a companion crown disc was shown in Paris, and this Foucault pronounced to be the finest piece of glass he had ever seen. Discs of 24 in. and 29 in. were produced in 1856, and a pair of 18-in. discs sold to Messrs. Alvan Clark and Sons in 1860 resulted, during the testing of the object-glass made from them, in the discovery of the companion to Sirius. A pair of 26-in. discs, produced in 1862, were worked by Messrs. Cooke and Son, York, for Mr. R. S. Newall, into the largest refractor then in existence, and this was later given to Cambridge University. In 1871 and 1874 Messrs. Clark worked pairs of 26½-in. discs, the former being used for the Washington refractor, with which the satellites of Mars were discovered. The 28-in. objective for Greenwich was finished by Sir Howard Grubb in 1887.

The question of the alleged supremacy of a particular country in any chosen industry may always be difficult of proof and largely a matter of opinion, but there is nothing in Messrs. Zeiss's detached historical data to invalidate, and much in the few facts we have just given to substantiate, the view that for some considerable period between 1848 and 1880 England held supremacy in the manufacture of optical glass. For a number of years from about 1880, during which period the discs for the great Lick and Yerkes telescopes were manufactured, Britain took a place second to that of France. It is significant that later in their letter Messrs. Zeiss speak of "the practical monopolisation of the glass market by French and English houses between 1848 and 1883."

(2) On the question of the subsidy the statement of Messrs. Zeiss must be accepted as authoritative, and we notice that it is limited to a State subsidy.

(3) But it is on the third point that issue can be directly joined with Messrs. Zeiss's arguments, which seem to suggest that the development of a national optical instrument industry is in no way dependent on, and would not be hampered by the absence of, an adequate home supply of optical glass. The instances they quote of advances in optical design and improvement in optical instruments prove nothing more than that dependence on a foreign supply for optical glass has not in the past entirely prevented some enterprising opticians and mathematicians from making distinct advances in optical design. But this is a far cry from establishing the proposition that a healthy and vigorous optical instrument industry has ever been, or can be, established in any country dependent entirely on foreign sources for its supply of optical glass. It is true that the British optical instrument industry has gained much since 1881 from its access to the products of Jena, but who shall estimate how much it has lost through the compara-

tive decline during that period of the optical glass manufacture in this country and the consequent absence of an active and close local *liaison* between the English mathematicians and opticians on one hand and the optical glass manufacturers on the other? The very presence in a country of an optical glass factory focusses interest on, and enlarges the conceptions of, the research problems connected with optical glass and its applications to optical instruments. The mathematicians and optical designers who are to open out new paths of advance should have the materials they need at hand and readily available. To allow the optical glass industry to die out in this country would mean that not only the spirit of invention in this industry, but also much of that spirit in the dependent industry of optical instrument manufacture, would pass over to the country in which there was close co-operation between these essentially related industries.

Messrs. Zeiss assert that the practical monopolisation of the glass market by French and English houses between 1848 and 1883 materially hampered the progress of the optical engineer. What reason have we to think that a similar monopolisation to-day by Germany would be less detrimental to the development of the optical instrument industry in this country? If Germany were the only source of supply of optical glass, what guarantee have we that preferential treatment would not be given to German optical manufacturers in matters of time, quality, and quantity, to the prejudice of optical manufacturers of other nations? Would the British engineering industry have reached its present excellence if there had been no efficient and vigorous iron and steel industry in this country, and consequently no continuous and intimate co-operation on the spot between the engineer and the iron and steel manufacturer? These considerations do not, of course, apply to all industries. But the optical instrument industry depends, and must depend, on constant and close co-operation and co-ordination between the optician and the mathematician on one hand and the manufacturer of optical glass on the other, and this cannot be complete and efficient in a country where the sole source of optical glass is a foreign supply.

We agree with Messrs. Zeiss's concluding statement that optical mathematicians of all countries need every extension of the choice of glasses at their disposal and would deplore their exclusion from any valuable material available to opticians in foreign countries. But there was no proposal in the article in NATURE of February 10 last designed or bound to have this effect, and, in any case, it leaves untouched the argument for maintaining, in the interests of British opticians, a healthy and progressive optical glass industry in this country.

THE WRITER OF THE ARTICLE.

The Tendency of Elongated Bodies to set in the North and South Direction.

AT one of the soirées of the Royal Society in 1920, Mr. A. E. Reeves showed an apparatus by means of which he believed he had obtained evidence that under suitable atmospheric conditions freely suspended elongated bodies set themselves with their longer axes in the geographical meridian. The evidence supplied at the time was not very convincing, and I understand that the subject is receiving further attention. In the meantime it may be pointed out that the earth's centrifugal force would act in a manner tending in the direction of the alleged effect, though the resulting couple is so minute that it would be extremely difficult to verify it experimentally.

If a horizontal rod be placed in the north and south direction, its southern end is—in the northern hemisphere—further away from the earth's axis. The centrifugal force is therefore greater at the southern end, and if the rod be slightly displaced, the horizontal component of that force will tend to bring the rod back into the meridian plane.

If ρ_0 be the distance of the centre of the rod from the earth's axis, that of a point at a distance s from the centre will be $\rho=\rho_0+s\cos\theta$, where θ is the co-latitude.

The horizontal component of the centrifugal force per unit mass at any point of the rod is $\omega^2\rho\cos\theta$. It is obvious that only the variation of the centrifugal force along the rod can produce an effect, so that we may write for its significant part $\omega^2 s\cos\theta$. If the rod be turned through an angle ϕ we must apply a further factor $\cos\phi$, neglecting small quantities of the second order. With σ for the mass per unit length of the rod, the couple acting on it becomes

$$\int\sigma\omega^2 s\cos^2\theta\sin\phi\cos\phi\,ds=\mathrm{I}\omega^2\cos^2\theta\sin\phi\cos\phi,$$

where I is the moment of inertia of the rod about its centre of inertia. The result will be the same for any lamina, whatever its shape or material. For small values of ϕ the vibrations of the rod are determined by:—

$$\mathrm{I}\frac{d^2\phi}{dt^2}=\mathrm{I}\omega^2\cos^2\theta\,.\,\phi,$$

which gives the period of a complete oscillation as independent of I and equal to $2\pi/\omega\cos\theta$, or $\mathrm{T}\sec\theta$, if T be the time of revolution of the earth. We find, therefore, that the suspended body tends to perform oscillations round the meridian position, the time of a complete oscillation being the same as that which Foucault's pendulum requires to turn round a complete circle, which in our latitude is about 31 hours.

The maximum torsional couple takes place when the rod is inclined at an angle of 45° to the meridian, and in a latitude of 45° it is $\frac{1}{4}\mathrm{I}\omega^2$. If it be desired to demonstrate it experimentally we should naturally turn to quartz fibres on account of their great carrying power. According to Sir Richard Threlfall (*Phil. Mag.*, vol. 30, p. 99, 1890), a quartz fibre 0·001 cm. in diameter can carry about 10 grams. A uniform rod of that weight and 30 cm. in length has a moment of inertia 750. By a suitable distribution of the weight of the rod this might be increased to 1000. The numerical value of the resulting couple then becomes

$$250\,\omega^2=1{\cdot}3\times10^{-6}.$$

For the couple due to a unit angular torsion of a quartz thread of unit length and radius r, Sir Richard Threlfall gives $4{\cdot}7r^4\times10^{11}$. If the length of the thread be 47 cm., we find finally $1{\cdot}3\times10^{-4}$, or about 20 seconds of arc for the angular torsion of the thread which balances the couple due to centrifugal force. I believe that the finest threads have a diameter about ten times smaller than that in the example given, but the weights would then have to be divided by 100, and the angular displacement would be between three and four minutes of arc. It is to be noted further that the effect cannot be observed directly because we cannot remove or apply the centrifugal force at will; the whole apparatus would therefore have to be turned through an angle of 45°, and the difference measured between that angle and the angular displacement of the suspended body.

ARTHUR SCHUSTER.

Is Scientific Inquiry a Criminal Occupation?

I ASK the question because, under the provisions of the Safeguarding of Industries Act, 1921, which came into operation on October 1, scientific workers and the public may be fined one-third of the value on all scientific appliances and on all chemicals—other than sulphate of quinine—imported into this country. Why this quinine salt alone of all chemicals should be free I do not understand, unless it be because it is largely used as a contraceptive and the philanthropic framers of the Act are alive to the fact, which of all others is the most important for us to recognise, that our country has double the population it can carry. Obviously, they are bent on discouraging and hindering scientific inquiry in every possible way; the Act can have no other effect; only a small proportion of the articles it covers are, or ever will be, made in this country. No more iniquitous measure was ever passed into law.

I have given notice that at the next meeting of the council of the Chemical Society I will move that action be taken forthwith to secure the repeal of the Act. If it be not annulled, scientific workers generally must agree to boycott all apparatus and materials of English manufacture. For once we must wake up and show that we can both help ourselves and protect the interests of our country.

Sir William Pope, in a recent speech dealing with American conditions, pointed out that chemists at least were so organised in the U.S.A. that they could make their voice heard with effect in the legislature. Here the legislature, bureaucracy in general, does not care a rap for science. A request made by Sir William Pope several months ago to the Board of Trade, on behalf of the Federal Council, that the Council might be heard on the proposed Bill was never more than formally acknowledged.

If we believe in our craft and its national value we must be militant in its protection.

I shall be glad to receive names and addresses (written legibly on postcards, please) of those who are willing to join in a memorial to the Prime Minister. If we desire to gain a position for science in this country, it is our duty to show, for once, that we can do something—that we are not mere talkers.

HENRY E. ARMSTRONG.
55 Granville Park, Lewisham, London, S.E.13.

Radiation and Chemical Action.

As regards Prof. Lindemann's criticism of the radiation hypothesis of chemical reactions, namely, that exposure of an aqueous solution of sucrose *plus* acid to sunlight brings about no sensible increase in speed, two possible ways of meeting the criticism present themselves. The first is to assert that the absorbing power of the water—that is, its screening effect on the molecules of the reactant solutes—is so great that the effective radiation of sunlight is reduced to negligible dimensions in a thin layer. This suggestion was made by the present writer at the Faraday Society's discussion on September 28 last. In the light of Mr. Taylor's experiments, this suggestion is seen to be untenable. The alternative way of dealing with the criticism is based on the relatively small absorption capacity of the reactant solutes as suggested by Mr. McKeown and the present writer (Journ. Amer. Chem. Soc., p. 1304, June, 1921). In the paper referred to it is shown that a clear distinction must be drawn between photochemical and thermal conditions, the former involving an absorption coefficient term. Briefly, the treatment of the photochemical process is as follows:—

Consider a layer of sugar solution, cross-section 1 cm.^{2} and of thickness dx, at a temperature T_1. The number of molecules of sugar present is given by pdx/kT_1, where p is the osmotic pressure in absolute units. If the layer be acted on by black-body radiation of temperature T_2, the total energy of frequency ν absorbed per second is $2\alpha E_\nu . d\nu . dx$, where α is the absorption coefficient of the sugar. The chemically effective energy absorbed is a fraction γ of the above, namely,

$$\frac{4\pi\alpha\gamma h\nu^3}{c^2} . e^{-h\nu/kT_2} . d\nu . dx.$$

This energy divided by $h\nu$ gives the number of sugar molecules decomposed photochemically per second, and therefore the fractional number decomposed in the layer per second is

$$\frac{4\pi\alpha\gamma\nu^2 kT_1}{c^2 p} . e^{-h\nu/kT_2} . d\nu.$$

For the action of sunlight this must be multiplied by $\theta^2/4 = 5{\cdot}42 \times 10^{-6}$, where θ is the apparent angular semi-diameter of the sun. Putting $\nu = 2{\cdot}86 \times 10^{14}$, $T_1 = 293°$ abs., $T_2 = 6000°$ abs., and $p = 22{\cdot}4/3{\cdot}42$ atmospheres (Taylor's experimental conditions), and giving to $d\nu$ the probable value 3×10^{13}, we get the fraction decomposed per second by the photochemical action to be $1{\cdot}06 \times 10^{-4}\ \alpha.\gamma$. The value of the *thermal* unimolecular velocity constant is approximately $4{\cdot}3 \times 10^{-6}$. Whilst actual data on the amount of absorption by the dissolved reactants are lacking, it is evident that the photochemical decomposition may readily be of the same order as the thermal effect, or even of a smaller order. It certainly does not exceed it by any such impossible magnitude as 10^{13}, and it is not surprising, therefore, that, with the very small time of exposure (about 1 second) given by Mr. Taylor to the droplets of the sugar solution, no appreciable change in the reaction velocity should have been observed.

A very rough estimate of the order of magnitude of $\alpha.\gamma$ may be obtained as follows:—In the first place, let us set $\gamma = 1$, its maximum value (in the case of anthracene γ has been estimated by Weigert as 0·04). As regards α, Coblentz has measured the percentage transmission of *solid* sugar in the infra-red region. In the neighbourhood of 1μ the value of α, obtained from Coblentz's data, is 46. In the case of 10 per cent. sugar solution the absorption coefficient, in so far as it depends on the sugar, would be reduced to about one-tenth of this value, corresponding to the tenfold dispersion of the sugar molecules. Hence, in so far as these data are applicable, one would infer that the maximum value of $\alpha.\gamma$ does not exceed 5, thus making the photochemical fractional decomposition at most of the order 5×10^{-4}, which is 100 times the thermal for the acid strength employed by Mr. Taylor. As the thermal change in 1 second is quite inappreciable, it is possible for the photochemical change to be inappreciable also. (I omit, for the sake of brevity, consideration of the fact that the inversion of sugar is not a simple process, but involves at least three consecutive processes, so that the precise value of the effective wave-length has not as yet been ascertained.)

Finally, it may be pointed out that no determination of the amount of radiation absorbed by the sugar in the solution has as yet been carried out by Mr. Taylor. If this were small, no chemical change in excess of the thermal change would be anticipated.

W. C. McC. LEWIS.
Muspratt Laboratory of Physical and Electro-Chemistry, University of Liverpool.

Habits of the Hedgehog.

IN NATURE of May 19 last (pp. 375–76) you were good enough to notice at length my paper on "The Ancient Legend as to the Hedgehog carrying Fruit upon its Spines," published by the Manchester Literary and Philosophical Society (Memoirs, vol. 63, No. 2). That paper was written with a view to elicit further evidence for or against the truth of the legend, and for such I asked definitely. Unfortunately, so far no one has communicated such to me. I have, however, just found by accident in *Nature Notes* for 1904 (vol. 16) two records which I had overlooked, and as both are entirely to the point I desire to direct attention to them.

In one Mr. F. B. Doveton, of Karsfield, Torquay, well known as a poet and musician, writing (p. 118) to inquire whether or not there was any truth in the old legend, adds: "My gardener declares that he has *seen* the feat performed in an adjacent orchard." In the other Mr. W. H. Warner, of Fyfield, Abingdon, wrote (p. 152): "I well remember, many years ago, meeting with hedgehogs in an Oxfordshire orchard, to the spines of which several apples were sticking. The apples had adhered to the spines, I had little doubt, when the creatures were rolling under the trees. That the hedgehog climbs the apple-tree and carries off the fruit (as country people say it is in the habit of doing) is, of course, absurd."

One would like, of course, further details in corroboration of both these records, but, unfortunately, such are not forthcoming, the two gentlemen in question being now dead. One can, therefore, only note that there seems no reason whatever to doubt the perfect *bona fides* of either. One of the records is, it is true, second-hand, but it is contributed by a gentleman of known standing, who clearly was prepared to accept the truth of his informant's statement. The other is a perfectly definite first-hand statement by a contributor who was (I have ascertained) likely to be trustworthy as a field observer.

When writing my article I omitted to mention the not uninteresting fact that the hedgehog, under its old English name of "urchin," enters into the armorial bearings of several English families, either as a charge or as a crest—in the latter case generally on a "mount." Among these is that of Claxton, which bears as its crest an urchin sable, bezantée. The bezants represented originally, without doubt, apples or other fruit stuck upon its spines.

London, October 5. MILLER CHRISTY.

The Flight of Thistledown.

IT appears that fully blown thistledown in the sunshine has a positive lifting power, apart from any general upward current of the air. I shall be glad if any readers of NATURE can bring facts to confirm or contradict this statement.

Experiments that give the best result can be carried out as follows:—Find a thoroughly healthy thistle on which the seed is completely ripe and is in process of being shed. By means of tweezers liberate a tuft of the down, and without in any way injuring the symmetry of the whorl take off the seed and the style, which may be recognised through its darker colour. If the tuft in its uninjured condition is liberated in the sunshine on a level plane, it will be found to soar out of sight like a balloon.

One explanation may be that the sun in shining on the fine cilia warms them and creates a small local current of warm air.

I have found that swansdown, which appears to afford a much larger surface for a given weight than thistledown, does not have the same soaring power. I am not sure that the effect is purely thermal; it may be electrostatic. It is very important that the whorl should be undistorted.

When the tuft is loaded with a seed it appears to be almost neutral, with perhaps a slight lifting power under the best conditions. The whorl and seed in a slight wind will sometimes be carried for several hundred yards, falling and rising in the air-currents. Taking the weight of the seed at 0·5 of a milligram, it is easy to calculate how many tufts would be required to raise 1 ton! MILES WALKER.

College of Technology, Sackville Street, Manchester, September 29.

A Method of Improving Visibility of Distant Objects.

THE idea may have been suggested before, but I believe it is not generally known and appreciated how very much the power of distinguishing detail in a distant object, and especially of perceiving it in its natural colours, may be improved by the simple device of fitting a small Nicol's prism in the eye-piece end of the observing telescope. The Nicol serves to cut off a great deal of the blue atmospheric "haze" which usually envelops a distant view, and mostly consists of polarised light. Details which are usually lost in the haze, such as the colour of distant rocks or of the vegetation growing upon them, then stands out in a very striking way.

It may also be worth mentioning that the visibility of the horizon at sea, especially in a haze, may often be wonderfully improved by a similar device. In this case the result is due in part to a suppression of the reflection from the surface of the water as seen through the Nicol's prism.

It is hoped that these observations will not be merely a scientific curiosity, but may find a practical application. C. V. RAMAN.

S.S. *Narkunda*, near Aden, September 18.

Gold-coloured Teeth of Sheep.

IN NATURE of June 9 last (p. 459), recently arrived here, is a communication from Mr. W. J. Lewis Abbott concerning the metallic-looking encrustation occurring on the teeth of sheep. In Proc. Linnean Soc. N.S. Wales (vol. 45, 1920, p. 324), abstracted in NATURE of April 21 last (p. 249) and reprinted in full in the *Chemical News* (vol. 122, p. 49), I give a detailed report, with analyses, of this and similar deposits on the teeth of a number of other animals, including man. In no case is the deposit of a metallic nature, but consists entirely of a salivary encrustation composed usually mainly of phosphate of lime with organic matter. The metallic appearance is an optical effect due to the refraction of light by the overlapping thin lammellæ of the deposit.

I should be interested in examining Mr. Abbott's specimen if he will send me one, and reporting the result in NATURE. THOS. STEEL.

Stephens Street, Pennant Hills, New South Wales, August 11.

The Constitution of Molecules.

THE remarks attributed to me in NATURE of October 13 (p. 219) give an incorrect impression of what I intended to convey to the meeting. The statement that the molecular heats "are inconsistent with the arrangement which has been adopted to account for chemical valency" was not made.

J. R. PARTINGTON.

October 14.

The Laboratory of the Living Organism.[1]

By DR. M. O. FORSTER, F.R.S.

MANY and various are the reasons which have been urged, at different periods of its history, for stimulating the study of chemistry. In recent years these have been either defensive or frankly utilitarian, in the latter feature recalling the less philosophic aspects of alchemy; moreover, it is to be feared that a substantial proportion of those who have lately hastened to prepare themselves for a chemical career have been actuated by this inducement. It is the duty, therefore, of those who speak with any degree of experience to declare that the only motive for pursuing chemistry which promises anything but profound disappointment is an affection for the subject sufficiently absorbing to displace the attraction of other pursuits. Even to the young chemist who embarks under this inspiration the prospect of success as recognised by the world is indeed slender, but, as his knowledge grows and the consequent appreciation of our ignorance widens, enthusiasm for the beauty and mystery of surrounding nature goes far in compensating for the disadvantages of his position. Not only do chemical principles underlie the operations of every industry, but every human being—indeed, every living plant and animal—is, during each moment of healthy life, a practical organic and physical chemist, conducting analytical and synthetical processes of the most complex order with imperturbable serenity. No other branch of knowledge can appeal for attention on comparable grounds; and without suggesting that we should all, individually, acquire sufficient chemical understanding fully to apprehend the changes which our bodies effect so punctually and so precisely—for this remains beyond the power of trained chemists—it may be claimed that an acquaintance with the general outlines of chemistry would add to the mental equipment of our people a source of abundant intellectual pleasure which is now unfairly denied them. In following the customary practice of surveying matters of interest which have risen from our recent studies, therefore, it is the purpose of this address to emphasise also those æsthetic aspects of chemistry which offer ample justification for the labour which its pursuit involves.

What is breakfast to the average man? A hurried compromise between hunger and the newspaper. How does the chemist regard it? As a daily miracle which gains, rather than loses, freshness as the years proceed. For just think what happens. Before we reach the table frizzled bacon, contemplated or smelt, has actuated a wonderful chemical process in our bodies. The work of Pavlov has shown that if the dog has been accustomed to feed from a familiar bowl the sight of that bowl, even empty, liberates from the appropriate glands a saliva having the same chemical composition as that produced by snuffing the food. This mouth-watering process, an early experience of childhood, is known to the polite physiologist as a "psychic reflex," and the various forms assumed by psychic reflex, responding to the various excitations which arise in the daily life of a human being, must be regarded by the chemical philosopher as a series of demonstrations akin to those which he makes in the laboratory, but hopelessly inimitable with his present mental and material resources. For, extending this principle to the other chemical substances poured successively into the digestive tract, we have to recognise that the minute cells of which our bodies are co-ordinated assemblages possess and exercise a power of synthetic achievement contrasted with which the classical syntheses, occasionally enticing the modern organic chemist to outbursts of pride, are little more than hesitating preliminaries. Such products of the laboratory, elegant as they appear to us, represent only the fringe of this vast and absorbing subject. Carbohydrates, alkaloids, glucosides, and purines, complex as they seem when viewed from the plane of their constituent elements, are but the molecular debris strewing the path of enzyme action and photochemical synthesis, whilst the enzymes produced in the cells, and applied by them in their ceaseless metamorphoses, are so far from having been synthesised by the chemist as to have not even yet been isolated in purified form, although their specific actions may be studied in the tissue-extracts containing them.

Reflect for a moment on the specific actions. The starch in our toast and porridge, the fat in our butter, the proteins in our bacon, all insoluble in water, by transformations otherwise unattainable in the laboratory are smoothly and rapidly rendered transmissible to the blood, which accepts the products of their disintegration with military precision. Even more amazing are the consequences. Remarkable as the foregoing analyses must appear, we can dimly follow their progress by comparison with those more violent disruptions of similar materials revealed to us by laboratory practice, enabling such masters of our craft as Emil Fischer to isolate the resultant individuals. Concurrently with such analyses, however, there proceed syntheses which we can scarcely visualise, much less imitate. The perpetual elaboration of fatty acids from carbohydrates, of proteins from amino-acids, of zymogens and hormones as practised by the living body are beyond the present comprehension of the biochemist; but their recognition is his delight, and the hope of ultimately realising such marvels provides the dazzling goal towards which his efforts are directed.

[1] Abridged from the presidential address delivered to Section B (Chemistry) of the British Association at Edinburgh on September 8.

The Vegetable Alkaloids.

It should not be impossible to bring the skeleton of these transformations within the mental horizon of those who take pleasure in study and reflection; and to those also the distinction between plants and animals should be at least intelligible. The wonderful power which plants exercise in building up their tissues from carbonic acid, water, and nitrogen, contrasted with the powerlessness of animals to utilise these building materials until they have been already assembled by plants, is a phenomenon too fundamental and illuminating to be withheld, as it now is, from all but the few. For by its operation the delicate green carpet, which we all delight in following through the annual process of covering the fields with golden corn, is accomplishing throughout the summer months a vast chemical synthesis of starch for our benefit. Through the tiny pores in those tender blades are circulating freely the gases of the atmosphere, and from those gases—light, intangible nothingness, as we are prone to regard them—this very tangible and important white solid compound is being elaborated. The chemist cannot do this. Plants accomplish it by their most conspicuous feature, greenness, which enables them to put solar energy into cold storage; they are accumulating fuel for subsequent development of bodily heat energy. Side by side with starch, however, these unadvertised silent chemical agencies elaborate molecules even more imposing, in which nitrogen is interwoven with the elements of starch, and thus are produced the vegetable alkaloids.

In this province the chemist has been more fortunate, and successive generations of students have been instructed in the synthesis of piperine, coniine, trigonelline, nicotine, and extensions from the artificial production of tropine; but until quite recently his methods have been hopelessly divergent from those of the plant. Enlightening insight into these, however, was given just four years ago by R. Robinson, who effected a remarkably simple synthesis of tropinone by the mere association of succindialdehyde, methylamine, and acetone in water, unassisted by a condensing agent or an increase of temperature. Based upon this experiment, R. Robinson (1917) has developed an attractive explanation of the phytochemical synthesis of alkaloids, in which the genesis of a pyrrolidine, piperidine, quinunuclidine, or *iso*-quinoline group is shown to be capable of proceeding from the association and interaction of an amino-acid, formaldehyde, acetonedicarboxylic acid and the intermediate products of these, taking place under the influence of oxidation, reduction, and condensation such as the plant is known to effect. Thus it may be claimed that Robinson's theory represents a notable advance in our conception of these vital changes, and that by means of the carbinolamine and aldol condensations involved fruitful inquiries into constitution and the mechanism of synthesis will follow.

The Nucleic Acids.

Owing to the venerable position occupied by alkaloids in the systematic development of chemical science, and to the success which has attended elucidation of their structure, many of us have become callous to the perpetual mystery of their elaboration. Those who seek fresh wonders, however, need only turn to the nucleic acids in order to satisfy their curiosity. For in the nucleic acid of yeast the chemist finds a definite entity forming a landmark in the path of metabolic procedure, a connecting link between the undefined molecules of living protein and the crystallisable products of katabolic disintegration. In the language of chemistry it is a combination of four nucleotides, linked with one another through the pentose molecule, *d*-ribose, which is common to each, and owing its acid character to phosphoric acid, also common to the component nucleotides. The latter differ from one another in respect of their nitrogenous factors, which are guanine (2-amino-6-oxypurine), adenine (6-aminopurine), uracil (2 : 6-dioxypyrimidine), and cytosine (2-oxy-6-aminopyrimidine), giving their names to the four nucleotides. The transformations undergone by nucleic acid in contact with tissue extracts have provided the subjects of numerous investigations extending over thirty years. In fact, the experimental material is of such voluminous complexity as to be unintelligible without the guidance of an expert, and in this capacity W. Jones has rendered valuable service by his recent lucid arrangement of the subject (1921). From this it is comparatively easy to follow the conversion of nucleic acid into uric acid through the agency of enzymes, and a review of these processes can serve only to increase our admiration for the precision and facility with which the chemical operations of the living body are conducted.

Considerable progress has been made also in localising the various enzymes among the organs of the body, particularly those of animals. Into the results of these inquiries it is not the purpose of this address to enter further than to indicate that they reveal a marvellous distribution, throughout the organism, of materials able to exert at the proper moment those chemical activities appropriate to the changes which they are required to effect. The contemplation of such a system continuously, and in health unerringly, completing a series of chemical changes so numerous and so diverse must produce in every thoughtful mind a sensation of humble amazement. The aspect of this miraculous organisation which requires most to be emphasised, however, is that an appreciation of its complex beauty can be gained only by those to whom at least the elements of a training in chemistry have been vouchsafed. Such training has potential value from an ethical standpoint, for chemistry is a drastic leveller; in the nucleic acids man discovers a kinship with yeast-cells, and in their common failure to transform uric acid into allantoin he finds a fresh bond of sympathy with apes. The overwhelming majority of people arrive at the grave, however, without having had the slightest conception of the delicate chemical machinery and the subtle physical changes which, throughout each moment of life, they have methodically and unwittingly operated.

Chlorophyll and Haemoglobin.

To those who delight in tracing unity among the bewildering intricacies of natural processes, and by patient comparison of superficially dissimilar materials triumphantly to reveal continuity in the discontinuous, there is encouragement to be found in the relationship between chlorophyll and hæmoglobin. Even the most detached and cynical observer of human failings must glow with a sense of worship when he perceives this relationship, and thus brings himself to acknowledge the commonest of green plants among his kindred. Because, just as every moment of his existence depends upon the successful performance of its chemical duties by the hæmoglobin of his blood corpuscles, so the life and growth of green plants hinge on the transformations of chlorophyll. The persevering elucidation of chlorophyll structure ranks high in the achievements of modern organic chemistry, and in its later stages is due principally to Willstätter and his collaborators, whose investigations culminated in 1913.

This is not an occasion to follow, otherwise than in the barest outline, the course of laboratory disintegration to which the chlorophyll molecules have been subjected by the controlled attack of alkalis and acids. The former agents reveal chlorophyll in the twofold character of a lactam and a dicarboxylic ester of methyl alcohol and phytol, an unsaturated primary alcohol, $C_{20}H_{39}.OH$, of which the constitution remains obscure in spite of detailed investigation of its derivatives; but the residual complex, representing two-thirds of the original molecule, has been carefully dissected. The various forms of this residual complex, when produced by the action of alkalis on chlorophyll, have been called "phyllins"; they are carboxylic acids of nitrogenous ring-systems, which retain magnesium in direct combination with nitrogen. The porphyrins are the corresponding products arising by the action of acids; they are carboxylic acids of the same nitrogenous ring-systems from which the magnesium has been removed. The phyllins and the porphyrins have alike been degraded to the crystalline base, ætioporphyrin, into the composition of which four variously substituted pyrrole rings enter. It is this assemblage of substituted pyrroles which, according to present knowledge, is the basic principle also of the blood-pigment, in which iron plays the part of magnesium in chlorophyll.

Anthocyans, the Pigments of Blossoms and Fruits.

Since the days of Eden, gardens have maintained and extended their silent appeal to the more gentle emotions of mankind. The subject possesses a literature, technical, philosophical, and romantic, at least as voluminous as that surrounding any other industrial art, and the ambition to cultivate a patch of soil has attracted untold millions of human beings. Amongst manual workers none maintains a standard of orderly procedure and patient industry higher than that of the gardener. Kew and La Mortola defy the power of word-painters to condense their soothing beauty into adequate language, whilst that wonderful triangle of cultivation which has its apex at Grasse almost might be described as industry with a halo.

Prior to 1913 the most fruitful attempt to isolate a colouring-matter from blossoms in quantity sufficient for detailed examination had been made by Grafe (1911), but the conclusions to which it led were inaccurate. In the year mentioned, however, Willstätter began to publish with numerous collaborators a series of investigations, extending over the next three years, which have brought the subject within the realm of systematic chemistry. For the purpose of distinguishing glucosidic and non-glucosidic anthocyans the names anthocyanin and anthocyanidin respectively were applied. The experimental separation of anthocyanins from anthocyanidins was effected by partition between amyl alcohol and dilute mineral acid, the latter retaining the diglucosidic anthocyanins in the form of oxonium salts and leaving the anthocyanidins quantitatively in the amyl alcohol, from which they are not removed by further agitation with dilute acid; the monoglucosidic anthocyanins were found in both media, but left the amyl alcohol when offered fresh portions of dilute acid.

The earliest of these papers, published in conjunction with A. E. Everest, dealt with cornflower pigments, and indicated that the distinct shades of colour presented by different parts of the flower are caused by various derivatives of one substance; thus the blue form is the potassium derivative of a violet compound which is convertible into the red form by oxonium salt-formation with a mineral or plant acid. Moreover, as found in blossoms, the chromogen was observed to be combined with two molecular proportions of glucose and was isolated as crystalline cyanin chloride; hydrolysis removed the sugar and gave cyanidin chloride, also crystalline. Applying these methods more generally, Willstätter and his other collaborators have examined the chromogens which decorate the petals of rose, larkspur, hollyhock, geranium, salvia, chrysanthemum, gladiolus, ribes, tulip, zinnia, pansy, petunia, poppy, and aster, whilst the fruit-skins of whortleberry, bilberry, cranberry and cherry, plum, grape, and sloe have also been made to yield the pigment to which their characteristic appearance is due.

Micro-biochemistry.

Amongst the many sources of pleasure to be found in contemplating the wonders of the universe, and denied to those untrained in scientific principles, is an appreciation of infra-minute quantities of matter. It may be urged by some that within the limits of vision imposed by telescope and microscope, ample material exists to satisfy the curiosity of all reasonable people, but the appetite of scientific inquiry is insatiable, and chemistry alone, organic, inorganic, and physical, offers an instrument by which the investigation of basal changes may be carried to regions beyond those encompassed by the astronomer and the microscopist.

It is not within the purpose of this address to survey that revolution which is now taking place in the conception of atomic structure. Fortunately for our mental balance the discoveries of the current century, whilst profoundly modifying the atomic imagery inherited from our predecessors, have not yet seriously disturbed the principles underlying systematic organic chemistry; but they emphasise in a forcible manner the intimate connection between different branches of science, because it is from the mathematical physicist that these new ideas have sprung. Their immediate value is to reaffirm the outstanding importance of borderline research and to stimulate interest in submicroscopic matter. This interest presents itself to the chemist very early in life and dominates his operations with such insistence as to become axiomatic. So much so that he regards the universe as a vast theatre in which atomic and molecular units assemble and interplay, the resulting patterns into which they fall depending on the physical conditions imposed by Nature. This enables him to regard micro-organisms as co-practitioners of his craft, and the chemical achievements of these humble agents have continued to excite his admiration since they were revealed by Pasteur.

Lamenting as we now do so bitterly the accompaniments and consequences of war, it is but natural to snatch at the slender compensations which it offers, and not the least among these must be recognised the stimulus which it gives to scientific inquiry. Pasteur's *Etudes sur la Bière* were inspired by the misfortunes which overtook his country in 1870–71, and the now well-known process of Connstein and Lüdecke for augmenting the production of glycerol from glucose was engendered by parallel circumstances. That acquaintance with the yeast-cell which was an outcome of the former event had, by the time of the latter discovery, ripened into a firm friendship, and those who slander the chemical activities of this genial fungus are defaming a potential benefactor. Equally culpable are those who ignore them. If children were encouraged to cherish the same intelligent sympathy with yeast-cells which they so willingly display towards domestic animals and silkworms, perhaps there would be fewer crazy dervishes to deny us the moderate use of honest malt-liquors and unsophisticated wines, fewer pitiable maniacs to complicate our social problems by habitual excess.

Conclusion.

In "The Salvaging of Civilisation," H. G. Wells has lately directed the attention of thoughtful people to the imperative need of reconstructing our outlook on life. Convinced that the state-motive which, throughout history, has intensified the self-motive must be replaced by a world-motive if the whole fabric of civilisation is not to crumble in ruins, he endeavours to substitute for a League of Nations the conception of a World State. In the judgment of many quite benevolent critics his essay in abstract thought lacks practical value because it underestimates the combative selfishness of individuals. Try to disguise it as one may, this quality is the one which has enabled man to emerge from savagery, to build up that most wonderful system of colonial organisation, the Roman Empire, and to shake off the barbaric lethargy which engulfed Europe in the centuries following the fall of Rome. The real problem is how to harness this combative selfishness. To eradicate it seems impossible, and it has never been difficult to find glaring examples of its insistence among the apostles of eradication. Why cry for the moon? Is it not wiser to recognise this quality as an inherent human characteristic, and whether we brand it as a vice or applaud it as a virtue endeavour to bend it to the elevation of mankind? For it could so be bent. Nature ignored or misunderstood is the enemy of man; Nature studied and controlled is his friend. If the attacking force of this combative selfishness could be directed, not towards the perpetuation of quarrels between different races of mankind, but against Nature, a limitless field of patience, industry, ingenuity, imagination, scholarship, aggressiveness, rivalry, and acquisitiveness would present itself; a field in which the disappointment of baffled effort would not need to seek revenge in the destruction of our fellow-creatures: a field in which the profit from successful enterprise would automatically spread through all the communities. Surely it is the Nature-motive, as distinct from the state-motive or the world-motive, which alone can salvage civilisation.

Before long, as history counts time, dire necessity will have impelled mankind to some such course. Already the straws are giving their proverbial indication. The demand for wheat by increasing populations, the rapidly diminishing supplies of timber, the wasteful ravages of insect pests, the less obvious, but more insidious depredations of our microscopic enemies, and the blood-curdling fact that a day must dawn when the last ton of coal and the last gallon of oil have been consumed, are all circumstances which, at present recognised by a small number of individuals comprising the scientific community, must inevitably thrust themselves upon mankind collectively. In the campaign which then will follow, chemistry must occupy a prominent place because it is this branch of science which deals with matter more intimately than any other, revealing its properties, its transformations, its application to existing needs, and its response to new demands. Yet the majority of our people are denied the elements of chemistry in their training, and thus grow to manhood without the slightest real understanding of their bodily processes and composition, of the wizardry by which living things contribute to their nourishment and to their æsthetic enjoyment of life.

It should not be impossible to bring into the general scheme of secondary education a sufficiency of chemical, physical, mechanical, and biological principles to render every boy and girl of sixteen possessing average intelligence at least accessible by an explanation of modern discoveries. One fallacy of the present system is to assume that relative proficiency in the inorganic branch must be attained before approaching organic chemistry. From the point of view of correlating scholastic knowledge with the common experiences and contacts of daily life this is quite illogical; from baby's milk to grandpapa's Glaxo the most important things are organic, excepting water. Food (meat, carbohydrate, fat), clothes (cotton, silk, linen, wool), and shelter (wood) are organic, and the symbols for carbon, hydrogen, oxygen, and nitrogen can be made the basis of skeleton representations of many fundamental things which happen to us in our daily lives without first explaining their position in the periodic table of all the elements. The curse of mankind is not labour, but waste; misdirection of time, of material, of opportunity, of humanity.

Realisation of such an ideal would people the ordered communities with a public alive to the verities, as distinct from irrelevancies of life, and apprehensive of the ultimate danger with which civilisation is threatened. It would inoculate that public with a germ of the Nature-motive, producing a condition which would reflect itself ultimately upon those entrusted with government. It would provide the mental and sympathetic background upon which the future truth-seeker must work, long before he is implored by a terrified and despairing people to provide them with food and energy. Finally, it would give an unsuspected meaning and an unimagined grace to a hundred commonplace experiences. The quivering glint of massed bluebells in broken sunshine, the joyous radiance of young beech-leaves against the stately cedar, the perfume of hawthorn in the twilight, the florid majesty of rhododendron, the fragrant simplicity of lilac, periodically gladden the most careless heart and the least reverent spirit; but to the chemist they breathe an added message, the assurance that a new season of refreshment has dawned upon the world, and that those delicate syntheses, into the mystery of which it is his happy privilege to penetrate, once again are working their inimitable miracles in the laboratory of the living organism.

Metaphysics and Materialism.

By PROF. H. WILDON CARR.

"IF the illusion of the scholastic method is that from mere forms we can deduce essences, then the world-view which we call materialism is only a scholastic pastime." This is the concluding sentence of Hermann Weyl's "Raum, Zeit, Materie." Whatever may be the case with the physicists, the mathematicians are under no illusion with regard to the completeness of the scientific revolution. The principle of relativity has not merely complicated the concept of physical reality; it has re-formed it. Mathematics is, and has always been recognised as being, a constructive process of the human mind exercised on physical existence. The old mathematics took its matter from physics; the new mathematics gives matter to physics. The effect is that the world-view which had become for physical science in the nineteenth century practically unchallengeable, and the acceptance of which had come to be regarded as the indispensable condition and only passport for those who would enter the ranks of scientific investigators, has become suddenly incredible. It is true, indeed, that it still has its defenders, and that it is held as firmly as ever by many who continue to be in their special departments authoritative teachers; but this does not alter the fact that for us to-day the world-view is changed, and it is not even strange that many leaders in scientific research still cling fast to the old view when we remember that the great originator of the modern inductive method in the seventeenth century, Francis Bacon, to the end rejected the Copernican theory.

Materialism does not stand for any particular theory of the nature of matter, but for the general world-view that matter, something *de facto* objective the ultimate constitution of which we may not know, and even may not be able to know, but which is entirely independent of our reason and of any thoughts we may have about it, exists and constitutes the reality of the universe, including reason and will, which as qualities or properties of some of its forms give rise to knowledge of it. This materialism reached the zenith of its expression in the Darwinian theory of natural selection, not in that theory itself, the truth of which there is no intention in this connection to call in question, but in the implications which were generally accepted as contained in it, and especially in the application which was made of it to rationalise a world-view. It seemed to point a way by which it was possible to conceive, and to some extent to follow in its history, an evolution which had produced mind from an original matter.

It may not be obvious at once that the mere rejection of the Newtonian concept of absolute space and time and the substitution of Einstein's space-time is the death-knell of materialism, but reflection will show that it must be so. If space is not endless, but finite (and this is the essential principle of the Riemannian geometry), and if time is not in its existence independent of space, but co-ordinate with the spatial dimensions in the space-time system (and this is the essential principle of the concept of the four-dimensional continuum), then the very foundation of the materialistic concept is undermined. For the concept of relative space-time systems the existence of mind is essential. To use the language of philosophy, mind is an *a priori* condition of the possibility of space-time systems; without it they not only lose meaning, but also lack any basis of existence. The co-ordinations presuppose the activity of an observer and enter into the constitution of his mind. If you distinguish, as, of course, you must and do, the observer from his space-time system, it is not a distinction of two separate existences externally related; they exist only in their relation, as when, for example, we distinguish an activity from its expression.

This is not a metaphysical gloss on a scientific principle, nor is it an attempt, as some may think, to obstruct the clear path of scientific progress with speculative cobwebs; it is the plainest matter of fact. Everyone who ignores it will simply find himself left stranded, unable to play any part in the conquest of the new realm opening before science.

In fact, it is not from philosophy, but from science, that this rejection of materialism comes. No one has expressed it with greater force and with fuller conviction of its fundamental importance than Prof. Weyl. In the introduction to the book which I have quoted, the whole of which is devoted to an exposition of the principle of relativity, he says:—

Whatever *matter* might ultimately prove to be, one thing we have always felt we knew for certain: that it is a substance underlying all change, and that every bit of matter could be measured as a quantity. Its substantial character found expression in a law of conservation. We believed the quantity of matter remained constant throughout all change. Till now philosophy has usually regarded this as *a priori* knowledge, unrestricted alike in its generality and in its necessity. To-day the certainty is changed to doubt. After physics in the hands of Faraday and Maxwell had set up another character, the *field*, above that of matter, and after mathematics on the other side, burrowing during the last century in a logical exploration beneath the basis of Euclidean geometry, had destroyed our confidence in its evidence, there has burst in our days a revolutionary storm which has swept away the ideas of space and time and matter, which till now had been the firmest supports of natural knowledge,—only, however, to make room for a freer and deeper insight into things.

Materialism is essentially a monistic and atomistic conception of reality. For it matter is primordial, and mind is derived. Philosophers from the beginning of philosophy have been conscious of the intellectual difficulty of such a concept, but it has always seemed, even to philosophers, a necessary presupposition of physical science. Science, it was conceded, must at least proceed *as if* it were so. The principle of relativity is the rejection of it, a rejection based on the discovery, not of theoretical difficulties, but of practical matters of fact. The supposed fundamental reality on which materialism as a world-view was supported has proved a vain illusion, and materialism is left in the air. The new scientific conception of the universe is monadic. The concrete unit of scientific reality is not an indivisible particle adversely occupying space and unchanging throughout time, but a system of reference the active centre of which is an observer co-ordinating his universe. The methodological difference between the old and the new is that mathematics is a material, and no longer a purely formal, science.

Damascene Steel and Modern Tool Steel.

THREE years ago Col. N. T. Belaiew presented to the Iron and Steel Institute the results of a very careful study of the general properties and structure of Damascene steel, and pointed out the great claims it had to the attention of all those interested in tool steel. He has now contributed a second paper, entitled "Damascene Steel," to the proceedings of the institute, September, 1921, in which an endeavour is made to substantiate this statement, especially as regards high-speed steels. In his view a marked analogy exists in the structure and also in some of the properties of both types of steel, and a comparative study, therefore, will probably prove beneficial in explaining the properties of these materials and improving the qualities of existing rapid-cutting tools.

Damascene steel belongs to the hypereutectoid series of carbon steels with an average content of about 1·5 per cent. of carbon. This carbon exists as iron carbide, Fe_3C, the well-known cementite; 1·5 per cent. of carbon represents 22·5 per cent. of cementite; about one-half of this is present with ferrite as the eutectoid pearlite; the remainder forms excess or free cementite. Of this the latter is distinctly the coarser, and in order to globularise or spheroidise the plates in which it exists in the casting, repeated careful hammering and heating are necessary. In this operation the plates are first broken down into small, irregularly shaped crystals, and are afterwards spheroidised, being of such a size that surface tension is able to exercise a marked influence on their ultimate form. The completeness of this spheroidisation is shown in the photomicrograph of an Indian Damascene blade contained in the author's paper, in which the large spheroids have resulted from free cementite, while the small ones have been obtained from the eutectoid cementite. In the author's first paper it was shown that a large amount of mechanical treatment was needed in order to produce this complete spheroidisation. The macrostructure shows that the cementite vein runs close up to the edge, and the Oriental maker must have relied most upon securing the best cutting properties in the cementite particles.

High-speed tool steel, which is an alloy steel containing from 16 to 20 per cent. of tungsten and from 3 to 5 per cent. of chromium, in addition to a carbon content not exceeding 0·75 per cent., together with vanadium up to 1 per cent., also belongs to the cementitic series of steels, and its structure in the annealed condition is strikingly similar to that of Damascene steel. Spheroidised carbide particles are embedded in a sorbitic matrix. To produce the characteristic high-speed hardness such steels have to be heated to incipient melting and then rapidly cooled in a current of air. Even after this treatment a certain amount of carbide remains undissolved, and there are indications that a moderate amount of it increases the cutting properties of the tool. What is important to notice is that the makers of high-speed steel emphasise the necessity of producing a particular type of structure under the hammer, and that during this operation the massive carbides and tungstides present in the ingot are broken down and uniformly distributed through it. Accordingly the ingots are first hammered into billets, and the latter are reheated and hammered a second time. This double treatment is indispensable and must precede the heat treatment proper by thoroughly breaking up and distributing evenly the carbides and tungstides throughout the steel.

Col. Belaiew then compares not only the structures, but also the respective processes of manufacture, and points out how similar they are. Both start with a cementitic steel; both require the greatest care in breaking and evenly distributing the carbides under the hammer; in both cases the amount of mechanical work done on a given article is very large; in both cases the structure of the resulting carbides is globular or spherulitic, while the matrix is martensitic; in both cases the cutting properties of the edge depend both on the matrix and the carbides, and the author is disposed to think that the *rôle* of the latter is the more important of the two. His studies in this field have led him to the belief that the workers in Damascene steel, while very strict as regards the hammering temperatures, did not lay anything like so much stress on the subsequent heat treatment.

In Damascene steel the degree of spheroidisation is always very high. This was not an end in itself, but was attained incidentally by the numerous cautious forgings and heatings which were designed to produce the greatest ductility possible. In high-speed tool steels spheroidisation is also attained, but the author holds that insufficient stress has been laid on this point by both makers and users, and that the scientific application of the spheroidising process would help to improve the qualities of existing steels. He considers also that another inference might be drawn from the Damascene process, namely, the proper study of the macrostructure in all cases. An Oriental maker would never manufacture a steel article without having satisfied himself by studying the "watering" that the distribution of the carbide particles was the best possible and in accordance with the shape and properties of the article. Neither would he find a buyer ready to accept a sword or a tool without a proper metallographic examination of it as a whole, and to this the Oriental watering lent itself well. The author suggests, therefore, that a proper examination of the watering of high-speed steel, whether in billets or in the finished article, should prove useful. It is interesting to notice that he found a certain degree of high-speed hardness in Damascene steel itself. This point would repay investigation, for if confirmed it would prove that, at any rate in certain cases, the use of alloy steels is unnecessary, and that they could be replaced by the cheaper carbon steels.

Obituary.

DR. JULIUS HANN.

THE death of Hann, which was briefly noted in the issue of NATURE for October 13, removes from the meteorological world the most prominent figure of the past generation and the most productive of all contributors to that branch of science. Hann was born at Schloss Hans, near Linz, in Austria, on March 23, 1839, and his youth was spent in the Alps at Kirchdorf, in Kremstal, some thirty miles south of Linz. After taking his degree in mathematics and physics, he took up a professional career as teacher of those subjects in the high school of Schottenfeld, Vienna, and afterwards at Linz. At the age of twenty-nine he was appointed on the staff of the Central Anstalt für Meteorologie at Vienna, which was then under the direction of Carl Jelinek. He succeeded Jelinek as director in 1874, and continued in office until 1897, when, at the age of fifty-eight, he gave up the appointment and retired to Graz, in Styria, in order to pursue his studies in meteorology; but, finding Graz inconvenient for that purpose, he returned to Vienna in 1900, and thereafter, as professor in the university, he occupied a room in the Central Anstalt on the Hohe Warte, and continued to work there until the end of his life.

Hann's chief and most continuous occupation was the editing of the *Meteorologische Zeitschrift*, which, in conjunction with Jelinek, he started on May 1, 1866, as the *Zeitschrift der Oesterreichischen*

Gesellschaft für Meteorologie. From 1877 to 1885 he was sole editor of that journal, and when, in the latter year, it was combined with the *Zeitschrift der Deutschen Meteorologischen Gesellschaft,* under the title which it now bears, Prof. W. Köppen, of the Seewarte, Hamburg, became his collaborator, and in 1892 Dr. G. Hellmann, of Berlin. More recently Dr. R. Süring, of Potsdam, shared the editorial duties, and at the beginning of this year Felix Exner, the present director of the Central Anstalt, relieved Hann, whose strength was failing. From its beginning the *Zeitschrift* has been recognised as the leading meteorological journal of the world, and as indispensable for any library in which the science of meteorology is represented.

Hann was one of the secretaries of the original international assembly of meteorologists at Leipzig in 1872, a member of the International Meteorological Committee from 1878 to 1898, and president d'honneur of the international conference at Innsbruck in 1905.

He was not only an exemplary editor of the *Zeitschrift,* but also an indefatigable contributor. Every number contained articles from his pen. No subject of meteorological interest escaped his notice. He was instrumental in obtaining for the journal all the data for out-of-the-way places that he could hear about. He moved, for example, our Meteorological Council to publish the results of the observations at the stations of the Royal Engineers and Army Medical Department which had been established through the influence of General Sabine, and more recently he always searched the blue-books of our scattered Colonies for information that would otherwise have been practically inaccessible to meteorologists. The whole world was his parish, and he took great care of it.

By May 1, 1906, Hann had been editor of the *Zeitschrift* for forty years, and the epoch was marked by the publication of a special volume of contributions made by his friends, pupils, and colleagues. It is known as the "Hann Band." It was edited by Dr. Hellmann, of the Prussian Institute, his colleague as editor of the *Zeitschrift,* and Prof. J. M. Pernter, Hann's successor as director of the Central Anstalt in Vienna.

In the spring of 1919 Hann's eightieth birthday was celebrated, and the opportunity was again taken to mark appreciation of his services by the collection of a fund to be placed at the disposal of the Vienna Academy for the encouragement of the study to which he had so assiduously and successfully devoted his life. By that time the disastrous effects of the war upon the finances of Austria had become realised, and Hann, in common with many other Austrian men of science, suffered lamentable privations, under which his health suffered, though he maintained his industry and assiduity. He died in Vienna on October 1.

Hann was a most voluminous author. Vienna was a great centre for the study of Erd-kunde, and the school of meteorology and geophysics, which owed much of its inspiration to Hann, is probably without a parallel in the world. The recital of his work by the Royal Meteorological Society at the award of the Symons medal in 1904 refers to 121 titles in the Royal Society catalogue and the following comprehensive books: Astronomical geography, meteorology, and oceanography in "Allgemeine Erd-kunde," published in 1881 by himself conjointly with Profs. Hochstetter and Pokorny; in 1883, "Handbuch der Klimatologie," which has now reached three editions, and is recognised everywhere as the standard work on that subject; in 1887, "Atlas der Meteorologie," forming part 3 of Berghaus's "Physikalischer Atlas"; and, lastly, in 1901, the "Lehrbuch der Meteorologie," "the most thorough treatise in all branches of the science," an indispensable work of reference for all meteorologists, which also has now passed into its third edition.

The amount of information contained in these works is extraordinary, and the method of presenting it equally remarkable, so much so that Hann's name is a household word wherever meteorology is discussed, and his position as the leading meteorologist of the world is unchallenged. While everything passed under his notice as editor of the *Zeitschrift,* he had a genius for seeing the bearing and noting the scientific connection of the various contributions of authors writing from many points of view. It is to Hann perhaps more than to anyone else that we owe the advances which have been made in recent years from a heterogeneous collection of meteorological erections towards a meteorological edifice on ordered scientific lines.

It is not practicable, within the limits of this notice, to make any enumeration of his own contributions to the science; his books are the best guides. From the first, mountain observations were among his favourites, and from that point of view he was the first to discover that a cyclone is in reality a cold creature. His studies in climatology led him also from the first to insist on the need for precision in the evaluation of mean daily temperature, and in recent years he wrote important papers on the subject with reference especially to the temperatures of tropical countries.

Hann was, indeed, the chancellor of the realm of meteorology. "It is said that the chief notary or scribe of the Roman Emperor was called chancellor either because he was entrusted with the power of obliterating, *cancelling*, or crossing out such expressions . . . as seemed to him to be at variance with the laws or otherwise erroneous; or, more probably, because he sat *intra cancellos,* within the lattice-work or railings which were erected to protect the Emperor from the crowding of the people." As one reads this definition of what a chancellor was and did, we may well think of Hann, indefatigably occupied in the seclusion of his room in the Hohe Warte of the Imperial City of Vienna, protected from the crowding of official duties, yet in continuous touch with the whole meteorological world, wasting no time over controversy, keen to appreciate the scientific laws and scrupulous impartially to place everything that complied therewith at the service of the whole scientific world.

Fully occupied in the enjoyment of his work, he was too busy for journeys that would separate him from it. Since 1898 he has not often been seen outside Vienna or his summer resort. He leaves a widow, a son, and two daughters to mourn his loss, which calls forth the assured sympathy of colleagues and friends in all parts of the world.

Hann received many distinctions. He was "Hofrat" in 1891, and subsequently was ennobled with the prefix "von"; but he made little display of the distinction. He had also the Ehrenzeichen für Kunst und Wissenschaft, and was a Knight of the Prussian Order "Pour le Mérite," a member of the Academy of Vienna, and honorary or foreign member of foreign academies and societies in all parts of the world. He was the recipient of the Buys Ballot medal, the Symons medal, and many other recognitions of his preeminent services. Napier Shaw.

Benjamin Harrison.

The late Benjamin Harrison was born on December 14, 1837, at Ightham, Kent, where his family had resided for several generations. Educated locally, he had the good fortune to be trained by two schoolmasters interested in science and archæology, and thus the natural trend of his mind was greatly stimulated. On leaving school at the age of fifteen he entered his father's shop, and after his father's death carried on the business of grocer until a few years ago. He passed peacefully away on October 1 after a few days' illness in the house in which he was born. He was married twice, his first wife dying in 1877, and his second wife (for many years an invalid) surviving him only a week. He leaves one son and two daughters.

In early life Harrison was a keen botanist and an enthusiastic collector of fossils and flint implements, and he soon got in touch with such well-known workers as the late Lord Avebury, F. C. J. Spurrell, and Roach Smith. In 1870 he met the late Sir Joseph Prestwich, who, perceiving the importance of his discoveries, encouraged him in many ways. As a result of Harrison's field work, Prestwich, in 1889, published his well-known paper on the Palæoliths of Ightham (Quart. Journ. Geol. Soc., vol. 45, pp. 270–294), followed in 1891 by the Darenth paper (*op. cit.*, vol. 47, pp. 120–160), and in 1892 by the paper on the plateau implements (Journ. Anthrop. Inst., vol. 21, pp. 246–262), Prestwich claiming for these rudely chipped flints a much greater antiquity than the Palæoliths. This was the beginning of the great "Eolithic" controversy which has not yet received its final solution, and it would appear as though there will always be two opinions respecting "Eoliths." Henceforward Harrison's spare time was spent in accumulating evidence in support of the "Eoliths" and in elucidating other prehistoric problems, whilst his house became a Mecca for all students.

Harrison's name will always be associated with "Eoliths," but it was his evidence that enabled Prestwich to establish the "hill group" of Palæoliths whilst the excavations carried on by Harrison at the rock shelters at Oldbury yielded many late Palæoliths which are now regarded as St. Acheul II. Harrison published but little, yet no one was more willing to assist others with his knowledge. An extremely well-read man, his ready wit, kindness of heart, and cheerful disposition endeared him to a large circle of friends, who now mourn the loss of "old Ben." In 1895 he was awarded the Lyell fund by the Geological Society, and in later life he was the recipient of a Civil List pension. Harrison was one of those humble workers for science who, in the face of great difficulties, rise superior to their surroundings by strength of character and industry, and leave an imperishable name behind.

Notes.

At a meeting of the Optical Society held on Thursday, October 13, the resolution passed early in 1915 suspending certain members, subjects of countries then at war with Great Britain, was revoked.

The Thomas Hawksley lecture of the Institution of Mechanical Engineers for the present year is to be delivered at the institution on Friday, November 4, at 6 o'clock, by Dr. H. S. Hele-Shaw, who will take as his subject "Power Transmission by Oil."

At the opening of the annual meeting of the Société de Chimie industrielle on October 10 the Dumas medal of the society and an illuminated address were presented by M. Dior, Minister of Commerce, to Sir William J. Pope.

"Early Relations of Egypt, Babylonia, and Syria" is the subject of a lecture to be delivered by Mr. Percy E. Newberry on Thursday, October 27, at 8.30 p.m., at the rooms of the Royal Society, Burlington House. This lecture is the first of a series on Egypt to be arranged by the Egypt Exploration Society. Tickets and further details can be obtained from the Secretary, 13 Tavistock Square, W.C.1.

The programme for the session 1921–22 of the Institute of Metals contains, in addition to announcements of general meetings of the institute, the first list of meetings of the newly-formed London Local Section. There are now in existence local sections in Birmingham, Sheffield, Glasgow, and London, and monthly meetings have been arranged at which papers by well-known workers will be read. Membership of local sections is open free to all members of the institute. The council of the institute has sent out, with the annual programme, a pamphlet comprising a series of notes for the guidance of those preparing papers for publication in the Journal of the Institute of Metals. This action should result not only in a commendable uniformity in the form of papers, but may also secure economy in the costs of production of scientific communications—a result much to be desired.

IN a thoughtful article in *The Scientific Monthly* for September (p. 214) Prof. Irving Fisher discusses impending problems in eugenics resulting from war, hygiene, birth-control, and immigration. He concludes that his surveys "seem to indicate that much of what we call progress is an illusion, and that really we are slipping backwards while we seem to be moving forwards. Human ambitions under the opportunities afforded by civilisation seem to sacrifice the race to the individual. We congregate in great cities and pile up great wealth, but are conquered by our very luxury. We seek imperial power and not only damage, but destroy, our germ plasm in war. We seek social status and education, but limit motherhood. Like moths attracted by a candle, we fly towards the glamour of wealth and power and destroy ourselves in the act."

A TIMELY and very necessary protest against the restrictions imposed upon the collection of birds and their eggs for scientific study in certain States in California appears in *California Fish and Game* (vol. 7, No. 3). It is pointed out that there "are about one hundred and fifty scientific collectors in California, as contrasted with more than one hundred and eighty thousand 'hunters,'" or, as we should say, "sportsmen." "Since practically all useful information regarding wild birds and animals," it is remarked, "is a result of the acquisition of specimens, the necessity for work of this kind is evident. The curtailment of scientific collecting must result in decreased scientific information. Furthermore, there is a danger of decreasing the number of ornithologists by cutting off the opportunity for the right kind of study. Our best ornithologists owe their early interest and their development largely to the unrestricted chance for securing specimens." We heartily endorse this protest.

MESSRS. E. A. HOOTON and C. C. Willoughby, in the Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University (vol. 8, No. 1), report the results of the excavation of an Indian village site and cemetery near Madisonville, Ohio. The occupation of this site covered the interval immediately preceding the first intercourse of the Indians of this region with Europeans, and extended into the proto-historic period, during which the inhabitants were able to procure a small amount of European metals and glass beads, either from early missionaries or travellers, or indirectly through their Indian neighbours. This culture in prehistoric times extended over a considerable portion of southern Ohio, and there appears to have been a migration of these Indians, driven south by the Iroquois, into the region of the Ohio River. Unfortunately there is little osteological material available from the States of Indiana and Kentucky for comparison with that of Madisonville, and the skeletal remains from the graves of the great earthwork builders of Ohio, now in the museum, have not been as yet systematically studied.

IN the *Fortnightly Review* for October Mr. Julian S. Huxley makes some suggestive observations on the evidences of variation and evolution as they occur in nature, derived from his study of the bird life of Spitsbergen during a visit to that island as a member of the Oxford University Expedition. The ringed or bridled guillemot is a simple Mendelian mutant of the common guillemot, differing only in the presence of a line of white encircling the eye and prolonged backwards across the side of the head. The two varieties live together and interbreed. The process of differentiation has progressed further in the Spitsbergen puffin and Mandt's guillemot, which are distinct northern geographical races of the common puffin and black guillemot, characterised by their larger size and paler colour. In the Spitsbergen geese, skuas, and eiders are found closely related species inhabiting the same region, but adapted to different modes of life. They are distinct in habit as well as in structure; the barnacle goose nests on the cliffs, the Brent goose on the low islands; Buffon's skua appears to keep more to the hills than Richardson's skua, while the king eider has been found nesting only singly on the tundra, not, like the common eider, in multitudes on islets.

AN excellent summary of our knowledge of the "bacteriophage" is given by d'Herelle, its discoverer, in *La Nature* of October 1, p. 219. The fundamental observation on this subject is as follows: a patient suffering from the bacillary form of dysentery is observed for, say, thirty days. Every day a sample of the fæces is mixed with broth, filtered through a porcelain filter to remove the bacteria present, and the series of filtrates is kept. At the end of the thirty days, thirty broth cultures of *B. dysenteriae* are prepared, and then to each culture tube one drop of a fæces filtrate is added, and the tubes are incubated. After twelve hours the following kind of result is obtained: tubes 1 to 6, unchanged; tubes 7 to 18, entirely clear and free from turbidity; tubes 19 to 30, unchanged. In the clear tubes the dysentery bacilli will be found to have dissolved, hence the disappearance of turbidity. D'Herelle maintains that the agent which causes the solution of the dysentery bacilli is an ultra-microscopic organism, to which he gives the name "bacteriophage," and which he supposes is of importance in cure and in immunity. Others believe that the agent is a catalyst which causes micro-organisms to produce autolytic ferments.

IN *Natural History* (vol. 21, No. 3), Mr. F. Morton Jones gives a most interesting account of the influence of insect-trapping plants on their insect associates, with special reference to those species of the moth Exyra which pass their entire life-cycle in intimate contact with pitcher plants of the genus Sarracenia. There are three species of Exyra, two of which are confined each to a single species of Sarracenia, and a third species, more adaptable than the other two, which seems equally at home in five other species of pitcher plant. Mr. Jones considers the plant–insect relation stage by stage in the life-cycle of the insects. He points out first those adjustments common to them all which relate to the general plan of the insect trap of Sarracenia, indicating an association ante-dating the splitting of the insect group, if not the plant group, into its several species. He then indicates the further adjustments which each species of moth shows to its own species of food plant, suggesting that the process of adjustment has continued, either coincident with the development of the plant species or at least following the insect's association with the plant. He concludes that the peculiar characters of the plant have been a significant factor in determining the course of evolution of the insects, and demonstrates the stages by which the latter have become adapted to their uniquely dangerous habitat.

WRITING in the August number of the *South African Journal of Industries* on "Science in the Service of the State," Mr. T. G. Trevor complains that the government of nations is still in the hands of the "predatory" class, although the civilisation of to-day depends in every detail of its existence on science and the labours of the "creative" class. He attributes the unfavourable position of the scientific and technical classes in the South African civil service to this fact. Scientific workers in the Union's civil service are pilloried indiscriminately with the clerical and administrative classes when the Parliamentary estimates are under discussion, yet since Lord Milner inaugurated the scientific departments of the Union Government service, "locusts have disappeared, malaria is a thing of the past, whole districts which were formerly regarded as impossible for white population are now fully peopled." The work on irrigation and cattle diseases has transformed vast areas. What is more important still, these services rendered "are infinitesimal compared to what they might be if it were once appreciated by the country at large what scientific work really is." The country should regard the expenses of those civil servants who are engaged in research and productive work as an investment. Instead, the Government offers a much lower salary to a chemist than the Rand Club offers to its billiard markers. Mr. Trevor outlines the administrative scheme under which the Union's men of science suffer. He is under the impression that things are vastly different in this country; there he is mistaken. Salaries are probably on a better level, but Mr. Trevor's criticism of the attitude towards science, the ignorance of the Parliamentarian, the contempt of the administrator, and the indifference of the average citizen, can be applied with equal appositeness to the condition of affairs here.

THE *Kew Bulletin* (No. 6, 1921) contains an account of a visit to the Cameroons and Nigeria by Dr. A. W. Hill, assistant director of the Royal Botanic Gardens, undertaken at the request of Sir Hugh Clifford, Governor of Nigeria. The main object of the visit was to report upon the Botanic Gardens at Victoria, Cameroons, which have suffered from some neglect during and since the war. A description of the gardens and associated buildings is given, and Dr. Hill strongly recommends their restoration to a state of proper order and efficiency. A large area of the British sphere of the Cameroons, from sea-level to about 1800ft., is occupied by large plantations, where cocoa, rubber, kola, oil palm, and bananas are extensively cultivated. The writer emphasises the need for a department of plant pathology at the Victoria Gardens for the investigation of the problems in relation to plant-diseases, selection, breeding, and the soil, which will arise on these extensive plantations. In addition to research, instruction should also be an important function of the garden. In Nigeria somewhat different conditions prevail; the soil is generally less fertile, and the cultivated plots are in native hands, and relatively small. Dr. Hill insists on the need for appointing agricultural chemists to study the principles of the native practices of cultivation, and to develop and improve any that are found to be of value. Economic botanists are also needed to investigate the native economic products and demonstrate their value for the good of the community. A brief visit was made to the Bauchi Plateau, a dry granitic area in Northern Nigeria, the botany of which had not previously been studied, and proved to be of considerable interest

IN a pamphlet published by the Institution of Water Engineers, Mr. T. Sheppard collects the published facts relating to Spurn Point and the lost towns of the Humber coast. As regards Spurn Point, plans, and in recent times, measurements, give accurate data as to the growth of the land. This has been so rapid that from the seventeenth century onward the lighthouse at the point has been continually moved westward. Thus between 1766 and 1771 the point is said to have grown 280 yards in length, although during the next century its growth was slower, and barely exceeded the same amount. The point is still extending in length and width, but if the growth continues a break will occur somewhere in this narrow spit of land. This has probably occurred in the past, since more than one old chart shows an island where the peninsula now is. The lost town of Ravenser, the site of which is uncertain, possibly existed on such an island. Founded by the Danes in the ninth century, Ravenser became in time a flourishing and wealthy port, but during the sixteenth century it was entirely swept away. The last reference to the place is said to have been in Leland's "Itinerary." Mr. Sheppard goes at length into the story of this and other towns that have now vanished from the south and east coasts of Holderness.

THE Jahrbuch des Norwegischen Meteorologischen Instituts for 1920 has been issued. As usual, it gives detailed data from Aas and Kristiania, a summary of the daily data from twelve important stations, and monthly means for some 70 stations. The volume also contains data from the Norwegian meteorological station at Green Harbour, Spitsbergen, including monthly means for 1919, and the daily records from July, 1919, to June, 1920. The Norwegian rainfall statistics for 1920 are published in "Nedböriakttagelser i Norge," and include data from 485 stations. A large-scale rainfall map of Norway is included.

SOME notes on the "rollers" of Ascension and St. Helena are given on the Meteorological Chart of the East Indian Seas for November. As is well known, the leeward shores of these islands frequently experience a heavy swell from the north-west, which, setting in without any warning, produces a heavy surf. At other times, but less frequently, the swell is from the south-west. During the continuance of these rollers, which are heaviest during January and February, landing is difficult and hazardous. Records for St. Helena show that rollers prevail on about twenty-five days, and heavy swell on rather more than twice as many days in the year. The cause of this phenomenon is not thoroughly understood, but it is supposed to be due to distant gales of wind, either in the North or South Atlantic, blowing in the direction of the islands. This explanation appears to suit the facts, but further investigations are required. It is probable that the heavy swell on the Gold Coast has a similar origin.

COL. SIR S. G. BURRARD's discussions of gravity anomalies in northern India and of the relation of the Himalayas to the Gangetic trough have been quoted in NATURE (vol. 97, p. 391, 1916, and vol. 103, p. 351, 1919). His review of the evidence in favour of the theory of isostasy appeared in the Journal of the Royal Geographical Society for July, 1920. In 1917 Mr. R. D. Oldham published his important memoir on "The Structure of the Himalayas and the Gangetic Plain" (Mem. Geol. Surv. India, vol. 42, pt. 2), in which he laid stress on the mass of comparatively light sediment in the great trough stretching southward from the mountains. Lt.-Col. H. McC. Cowie (Survey of India, Prof. Paper 18, 1921) now puts forward "A Criticism of Mr. R. D. Oldham's Memoir," in which he reviews the whole series of gravity anomalies in the region as at present known, and concludes that a deficiency of mass, widespread throughout the Gangetic area, is insufficient to explain the "very rapid fall, in a northerly sense, in the value of the residual between Dehra Dūn and Kaliana, Birond and Bansgopal, Siliguri and Jalpaiguri." The observed pendulum deflections at these and a number of other stations, and those deduced by taking into consideration a Gangetic trough in addition to surface masses, are given in Table VIII. Two series of residuals are obtained by subtracting from the observed deflections, first, the calculated deflections produced by the surface-features and their compensation, and, secondly, these deflections as modified by a trough of the dimensions given by Mr. Oldham. Lt.-Col. Cowie finds so little difference between the resulting quantities that the characteristic anomaly on the Himalayan edge remains for him a problem awaiting solution. The large contoured map on the scale of 1 : 3,000,000 accompanying his paper includes the whole "Himalayan-Tibetan mass," and has many obvious uses. Kaliana is given on it as Kallāna.

THE October issue of the *Philosophical Magazine* contains a paper on "Escapements and Quanta," which Sir Joseph Larmor communicated to the British Association at Edinburgh, and in which he suggests that the atom may be analogous to a clock. The outer electron system of the atom, on which its chemical and spectroscopic properties depend, and which has certain definite rates of oscillation, would correspond to the pendulum, or better, to a compound pendular system of a clock, and the inner core of the atom to the spring which, by means of the escapement, slowly imparts its energy to the pendulum in quanta fashion. Dynamical systems of this type are worth introducing into our theories of atomic constitution, and will, Sir Joseph thinks, well repay investigation.

THE Société Genevoise d'Instruments de Physique send us an account of their new "universal microscope for mineralogical researches," intended for research work on the optical characters of microscopic crystals in thin sections of rocks. It can be arranged either so as to have the objective rigidly attached to the rotating stage in the manner devised by Nachet, or with the objective stationary while the stage rotates, and the Fedorov or theodolite stage can then be employed. There is apparently no mechanism for the simultaneous rotation of the Nicols. The stage can be lowered for use with objectives of long focal length—a circumstance which will be very useful in many cases. Another unusual feature is the use of adjustable adapters which remain fixed to the objectives. By means of these the small differences of centring between different objectives may be eliminated. A similar arrangement has been employed in this country.

THE concluding remarks of the chairman, Mr. P. Raghavendra Rao, of the Board of Scientific Advice —to use its new name—at the Mysore Economic Conference held at Bangalore in June, dealt with the activities of the Board during the preceding year. The Government has been approached with the view of inducing it to instal plant for the production of sulphuric acid at the Bhadravati Iron Works. It is pointed out that as charcoal is the chief fuel used, it would be of considerable economic advantage if the grey acetate of lime, which is obtained from the acetic acid formed during production of charcoal, could be converted into glacial acetic acid on the spot. The Board has also considered the question of the manufacture of tannin extracts and of lac, as well as matters relating to the development of the sugar industry. Arrangements have been made by which one or two Indian students can receive a training in the scientific manufacture of sugar under the Imperial Department of Agriculture, Barbados, West Indies, and it is stated that the course is open to a student of chemistry or any other who is prepared to consider it.

A NOTE of the meeting at Bergen of the International Commission for the scientific investigation of the upper air, is given in the *Meteorological Magazine* for September. The meeting commenced on July 26, and was continued on the following days. The preceding (seventh) meeting of this Commission was held in Vienna in 1912, though at that meeting the time was mainly occupied with business questions, little time being given to scientific discussion. At the Bergen meeting, this year, the leading place was given to scientific contributions from the members of the Commission and other meteorologists interested in the work. Much attention was directed to further developments in the study of the Polar Front. Broadly speaking, the Scandinavian school finds that depressions occur in families of four, each following a track slightly further south than its predecessor, the first and third of the family being generally more intense than the second and fourth. The note mentions that on the average a new family begins every $6\frac{1}{4}$ days. The Commission decided that an international publication of the results of the investigation of the upper air on certain selected days should be continued, and a table is given showing the dates when the ascents are to be made. A report of the proceedings of the meeting has been published, and was presented to the International Meteorological Committee recently held in London.

AT the autumn meeting of the Iron and Steel Institute recently held in Paris a paper was contributed by M. L. Guillet on "The Position of the Metallurgical Industries of Northern and Eastern France: Their Destruction and Reconstruction." M. Guillet himself writes with first-hand knowledge of this subject, and emphasises that of the total destruction only a very small proportion was due to actual war damage; the bulk of it was deliberate, and had as its object the putting of French iron and steel works out of action for many years to come. He states that in some regions the work of demolition was carried out so systematically that a whole arsenal of works-breaking machinery was created for the purpose. He himself removed at the Biache Saint-Vaast Copper Works, near Arras, a whole series of high-explosive cartridges from the principal parts of the plant and machinery. The work of reconstruction has been truly remarkable considering the conditions under which it had to be undertaken. After the armistice it was impossible to rely on finding anything which might be needed in the immediate locality. Machinery, raw materials, and labour were lacking, and the workmen were scattered far and wide. A lack of coal and means of transport made it impossible to rely upon regions still intact. Details are given of how this situation was met in a number of the most important metallurgical districts and of the results accomplished. Despite the above handicaps and financial difficulties arising out of the incomplete Peace Treaty, the works are little by little resuming their activities. Moreover, in the course of their reconstruction they have been completely modernised, and it is probable, therefore, that their efficiency will be considerably increased. M. Guillet regards the outlook as both prosperous and promising.

AMONG the forthcoming books included in the announcement of the Cambridge University Press in NATURE of September 22, p. 131, was one by Major P. A. MacMahon, "New Mathematical Problems," the title of which, we are now informed, should have been given as "New Mathematical *Pastimes.*" The book contains a series of puzzles based on the permutations and combinations of elementary geometrical shapes, and is a contribution to the literature of mathematical recreations.

"OCEAN Research and the Great Fisheries," by G. C. L. Howell, is announced by the Oxford University Press as almost ready. The author writes about the organisation of ocean research, statistics, the apparent effect of the war on fish supplies, fish culture, etc., and discusses the problems connected with a dozen of the most important kinds of fish, dealing with the varieties separately.

"THE Dictionary of Applied Physics," which Messrs. Macmillan and Co., Ltd., propose to issue under the editorship of Sir Richard Glazebrook, is now in an advanced stage of preparation. The work will appear in five volumes of 600–700 pages each, the subjects of which are as follows:—(1) Mechanics, Engineering, and Heat; (2) Electricity; (3) Metrology, Meteorology, and Measuring Appliances; (4) Metallurgy and Aeronautics; and (5) Optics, Sound, and Radiology. It is hoped that vol. 1 will be ready for publication early in 1922, and it will contain important articles by a number of distinguished contributors. Sir Alfred Ewing has written on thermodynamics, the liquification of gases, and refrigeration, Sir Charles Parsons and Prof. Stoney on the steam turbine, Sir Dugald Clerk and Mr. Burls on the internal-combustion engine, Prof. Dalby on the balancing of engines, and Dr. E. H. Griffiths on the mechanical equivalent; while Dr. Horace Lamb has provided several articles on related mathematical questions. Other topics dealt with are friction, lubrication, ship resistance, manometers, the determination of the elastic constants of materials, dynamometers, the theory of elasticity and its application to structures, hydraulics, and the kinematics of machinery. In the heat section Dr. Coblentz has written on the experimental verification of the laws of radiation, Mr. C. G. Darwin on radiation theory and the quantum, Mr. W. C. D. Whetham on the phase rule, Mr. Ezer Griffiths on calorimetry and pyrometry, and Prof. Porter on thermal expansion. The editor has thus secured the services of a recognised authority on each of the subjects dealt with, and this plan has also been adopted in the remaining volumes which the publishers hope to issue at short intervals after the appearance of the first.

Our Astronomical Column.

THE LUNAR ECLIPSE OF OCTOBER 16.—The three interesting phenomena of the present year—the solar and lunar eclipses and the occultation of Venus—have all been favoured with fine weather in London. The chief interest of the lunar eclipse on October 16 was the varied colouring of the shadow. The outer portion was bluish- or slate-grey, the inner portion decidedly ruddy. It is not difficult to give an explanation; the light reaching the outer portion needed only a small amount of refraction, and passed through the higher regions of the earth's atmosphere, suffering but little absorption, while that near the centre of the shadow underwent large refraction, and must have passed close to the earth's surface, so that only the long red waves could get through. Some have reckoned this as a dark eclipse; the present writer would class it as of average character, having seen both darker and brighter eclipses. There was a large amount of lunar detail plainly visible in the outer region of the shadow; a Greenwich photograph with 40 seconds' exposure showed the Maria and bright rays conspicuously. Two of the predicted occultations were successfully observed at Greenwich. The sky near the moon was too bright to permit the others to be seen.

REFORM OF THE CALENDAR.—The Astronomical Union will meet next year in Rome, and among the committee meetings that will be held there is one on calendar reform. This committee is presided over by Cardinal Mercier, and includes Sir F. W. Dyson and Prof. Sampson from Great Britain, MM. Bigourdan and Deslandres from France, M. Lecointe from Belgium, and Prof. Campbell from the United States. The main outlines of the reforms to be discussed include a more uniform arrangement of the lengths of the months, alteration in the position of the leap day (the end of the year would be far more convenient from the point of view of astronomical tables), and making the incidence of the week-days the same every year by placing one day a year (two in leap year) outside the weekly reckoning. The further question of the fixation of Easter may be raised, but the committee will, of course, not attempt to make any change without seeking ecclesiastical co-operation. The question of calendar reform has been mooted for many years, but it is much easier to recognise the inconveniences of the present system than to agree on an alternative one.

THE SPECTRUM OF ϕ CASSIOPEIÆ.—Major W. J. S. Lockyer and Mr. D. L. Edwards contribute a paper on this spectrum to the June Monthly Notices. They show that it is intermediate between those of α Cygni and γ Cygni. Thus the hydrogen lines and the enhanced lines of manganese and iron progressively weaken from α to γ, while the remaining iron lines and the enhanced lines of titanium progressively strengthen. Seven stars are indicated with spectra almost exact replicas of that of ϕ Cassiopeiæ, including Canopus and α Leporis. Eight other stars are indicated with spectra intermediate between those of ϕ Cassiopeiæ and γ Cygni; they include the two Cepheid variables, η Aquilæ and δ Cephei; it is further stated that the spectra of these two approach that of ϕ Cassiopeiæ at maximum, and that of γ Cygni at minimum. Reasons are given for inferring that all the stars discussed are giants, with temperatures highest in the α Cygni type and lowest in that of γ Cygni.

The paper also discusses the differences between the spectra of giant and dwarf stars of spectral type F, Procyon being taken as a representative of the dwarfs. The hydrogen lines are much sharper in the giant stars, and the enhanced metallic lines more pronounced.

Reproductions are given of five of the spectra discussed, and it is also pointed out that the research has some importance in connection with the interpretation of the spectra of novæ, the earlier stages of which resemble the α Cygni type.

MINOR PLANETS.—*Astr. Nach.*, No. 5122, contains an important research by Edzard Noteboom on the perturbations of Eros, in continuation of work on the subject by Prof. Witt, the discoverer of Eros. The actions of Mercury, Uranus, and Neptune, though almost insensible, are included for completeness. The observations of eleven oppositions, from 1893 to 1914, are compared with theory and twenty-four normal places formed. After correcting the earth's mass, the comparison shows that the largest discordance is 4″, most of them being under 2″. The research was undertaken mainly to investigate the large terms produced by the earth, and thus obtain a correction to its mass. The combined mass of the earth and moon was found to be $1/(328370 \pm 102)$, leading to a solar parallax of 8·799″.

It is important that Eros should be well observed at every opposition. Only two observations were available in 1903. It is still of magnitude $11\frac{1}{2}$, and a continuation of Mr. Seagrave's ephemeris for Greenwich midnight is given:—

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Oct. 19	22 1 8	10 45	Nov. 4	22 4 26	9 30
23	22 0 38	10 22	8	22 7 21	9 20
27	22 1 1	10 2	12	22 10 59	9 13
31	22 2 20	9 45	16	22 15 19	9 10

The same issue of *Astr. Nach.* contains an investigation of the orbit of the planet 887 Alinda. It was discovered four years ago by Prof. Wolf, and approaches closely to the earth's orbit in perihelion, but has large eccentricity; as its period of four years is about one-third of Jupiter's period, the perturbations by that planet will be large. They have been investigated by Mr. K. Schütte, who gives a search ephemeris for the present return. The recovery of the planet is desirable, but as the magnitude is 13·3 and the declination south, it is useless to give the ephemeris here.

THE CENTENARY OF "ASTRONOMISCHE NACHRICHTEN."—*Astronomische Nachrichten*, founded in 1821 by Schumacher with the encouragement of Gauss, has celebrated its centenary by the publication of a remarkable "Jubiläumsnummer," which contains articles by astronomers in all the continents, who join in expressing appreciation of the valuable work that this publication has done for astronomy. It has from the beginning exhibited a cosmopolitan spirit, aiming at the general and rapid diffusion of important information, and giving a large portion of its space to articles from other countries than its own. As Mr. R. T. A. Innes says in a cordial message: "Continuity has been maintained; the *Astronomische Nachrichten* is in 1921 what it was in 1821, the astronomer's newspaper, its columns ever open for astronomical news from any part of the world."

One of its features has been the absence of fixed days of publication, all important communications being published with the smallest possible delay. It has, however, conformed almost exactly to an average weekly interval. The periodical has been invaluable to workers in the special lines of comet and minor planet observation, and the advance of knowledge in these branches is largely due to its aid.

The following is a list of the principal contents of the "jubilee number." O. Bergstrand writes on the effective wave-lengths of the galactic stars; A. S. Eddington on the dynamical equilibrium of the stellar system; P. Guthnick and A. A. Nijland on the Cepheid problem; J. G. Hagen on dark nebulæ; H. Shapley on the galactic distribution of the B stars; and H. v. Zeipel on the masses of stars in clusters. The list is not exhaustive, but will serve to give an idea of the varied contents of this memorable publication.

Geology of the South Wales Coalfield.[1]

As is pointed out by the Director in the preface to the memoir under notice, the district, though not containing many deposits of economic importance, includes a very extensive series of rocks, ranging from the Ordovician to the New Red, and the hope is expressed that the district will be recognised as a typical area for the study of the formations represented, as developed in S.W. Wales.

The area shows considerable physical diversity. The highest ground is formed by remnants of a plateau mainly consisting of Lower Old Red Sandstone. The remnants are separated from one another by erosion-valleys and by level tracts chiefly composed of Carboniferous Limestone. The latter are referred to as the limestone flats, and considered to be probably the work of the Pliocene sea. The remarkably level character of these flats is shown in the frontispiece. The coast is deeply indented by partly drowned valleys (rias), of which the chief is Milford Haven. Many of the valleys are independent of the geological structure, and afford examples of superimposed drainage.

The oldest rocks occurring in the district are shales and sandstones belonging to the Llanvirn series exposed in the anticlines of Freshwater East and Castlemartin Corse. Here, too, are seen Silurian rocks, which both lithologically and in fossil-contents are of the Welsh-borderland type.

The Old Red Sandstone is specially interesting from the intercalation in the upper beds of bands containing a marine Devonian fauna. These bands, which were originally noted by de la Beche, and afterwards referred to by Salter, have yielded more than fifty species of fossils, by far the greater number coming from Freshwater West. The author considers that apart from these marine intercalations in the highest beds, the Old Red Sandstone represents an aqueous deposit formed under "continental" conditions. He does not believe that any of the rocks are directly æolian, the sandstones being too well bedded and conglomeratic to represent sand-dunes, and though the marls may be formed of wind-borne dust, it probably settled in water.

The Old Red Limestones "probably represent precipitates thrown down as the fresh, tributary waters carrying the calcium carbonate in solution mingled with the more saline water of the basin of deposition." The breccias and conglomerates of the Upper Old Red contain much igneous material, chiefly acid lavas, which, Dr. H. H. Thomas points out, "show a general resemblance to the pre-Cambrian and lowest Palæozoic rocks of Pembrokeshire, more particularly of the part north of St. Bride's Bay." In the Ridgeway conglomerate of the Lower Old Red Sandstone the pebbles are chiefly quartzite, igneous material being almost unrepresented.

The Carboniferous Limestone Series (Avonian) is perhaps the most interesting formation in the area, and the full account now available will be most acceptable to all students of these rocks. The author, like all other workers on the Carboniferous Limestone, has been deeply influenced by the work of the late Dr. Vaughan, to whom he "cannot adequately express his indebtedness." The faunal subdivisions recognised are in the main those of Vaughan's original paper, but the author draws the line between the Upper and Lower Avonian at the top of the C_1 beds, where a marked transgression occurs in the northern part of the South Wales area, instead of at the top of C_2, where Vaughan originally drew it.

The study of the rock-types of the Carboniferous Limestone Series is one which the author has made peculiarly his own, but he has already treated the subject so fully in describing the rocks of Gower that there is comparatively little of a novel character in the present memoir. A description is given of the interesting reef dolomites, and of the characters which lead the author to compare them with the reef or knoll limestones of Clitheroe and the Belgian Waulsortian. They occur in the C beds of the extreme south-west corner of the district, and appear to be essentially bryozoan reefs. Oolites have been recognised at an exceptionally large number of levels in the Lower Avonian. In very numerous respects mentioned by the author the rock-types are identical with those of the Bristol district. The term "Zaphrentid-phase," which was introduced by Vaughan, but not defined, is employed by the author, who defines his use of the term. A very lengthy fossil list is included.

The "Millstone Grit"—the term used to include the sandstones and shales intervening between the Carboniferous Limestone and the Coal Measures—though well exposed, is greatly disturbed, and the strata are difficult to correlate. The lower beds are shown to contain radiolarian chert and fossils of Pendleside type, while the presence of certain plants in the upper beds appears to indicate an horizon as high as the Middle Coal Measures of the Midlands.

Certain deposits of a peculiar character preserved in fissures or cavities of the Carboniferous Limestone are the only ones referred to the New Red (Trias). The most remarkable of these are the gash-breccias, which are fully described, and illustrated by an admirable plate. The author considers that they are probably due to the collapse of the roof and sides of cavities formed by the underground solution of the limestone.

A particularly full and interesting account is given of the earth-movements which have affected the district, and while by far the most important are the post-Carboniferous (Armorican) movements, others occurred between the Llanvirn and Wenlock periods, between the Ludlow and the Lower Old Red Sandstone, between the Upper and Lower Old Red Sandstone, between the Upper and Lower Avonian, and between the Carboniferous Limestone and Millstone Grit. All the chief strike-faults are overthrusts of Armorican date, while the cross-faults, which are tabulated, also appear to belong in the main to the same period of disturbance.

The district differs from Gower and some other parts of South Wales in that glacial deposits are nowhere seen resting in clear sequence on undoubted raised-beach.

The memoir is illustrated by five fine plates and an admirable series of sketch-maps. It everywhere bears evidence of the minute observation and thoroughness which are so characteristic of the author's work.

[1] Memoirs of the Geological Survey: England and Wales. "The Geology of the South Wales Coalfield." Part 13: "The Country around Pembroke and Tenby." By E. E. L. Dixon. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1921.) 8s. net.

National Institute of Agricultural Botany.

THE King and Queen paid an informal visit to the headquarters of the National Institute of Agricultural Botany at Cambridge on Friday, October 14. They were accompanied by Princess Mary, and the suite included the Minister of Agriculture, Sir Arthur Griffith-Boscawen. Their Majesties were received at the institute by Sir Lawrence Weaver, chairman of the institute, and Lady Weaver and Mrs. Brinton, chairman and founder of the Housing Association for Officers' Families, by which the fourteen houses adjoining the institute have been built for the accommodation of officers' widows and disabled officers. After the presentation of a number of visitors and members of the council of the institute, the Royal party were conducted round the buildings by Sir Lawrence and Lady Weaver and the director of the institute, Mr. Wilfred H. Parker. They were shown an exhibit of wheats and barleys by Prof. Biffen and Mr. E. S. Beaven, the different processes of seed-testing by Mr. C. B. Saunders, chief officer of the Official Seed Testing Station, and a collection of potatoes arranged by Dr. Salaman and Mr. H. Bryan, the superintendent of the Potato Testing Station, Ormskirk. The Royal party were then conducted to the council room, where they made the first entries in the visitors' book, and, after the King had planted a mulberry tree in front of the institute to commemorate his visit, inspected the domestic quarters. Mrs. Brinton then took their Majesties to visit the houses occupied by officers' widows, in front of which a second mulberry tree was planted by the Queen.

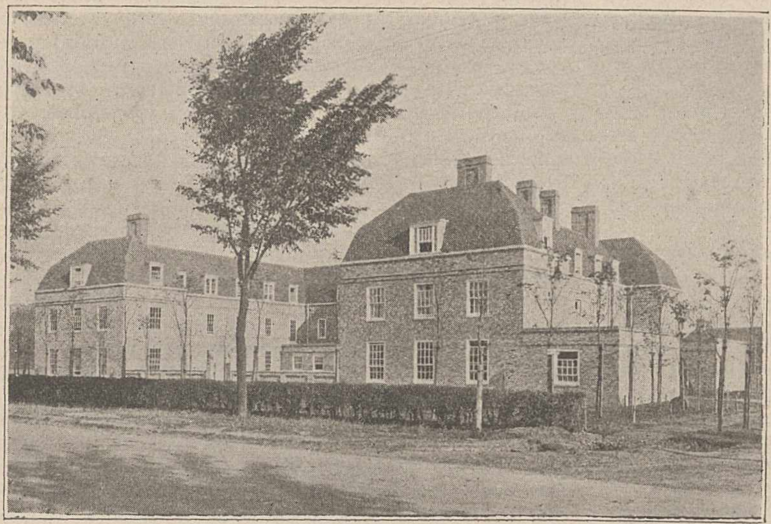

FIG. 1.—National Institute of Agricultural Botany, Cambridge.

The necessity for such an organisation as the institute became very apparent during the latter years of the war, when the imperative need for an increase of food production led the Government to introduce a measure of seed control. This resulted in the establishment, in the autumn of 1917, of the English Official Seed Testing Station, and it was from the study of Continental methods of seed control that the National Institute of Agricultural Botany came to be founded in the early part of 1919 by Sir Lawrence Weaver, now the Second Secretary of the Ministry of Agriculture and Fisheries, who has been responsible for the administration of the new control of seeds. The institute has been modelled generally on the lines of the famous Svalof organisation in South Sweden.

The institute was constituted as a charitable trust. Large contributions to the trust fund were received from Sir Robert McAlpine and Sons, Viscount Elveden, members of the agricultural seed trade of the United Kingdom, the milling industry, and other agricultural trades, while a generous gift of a 334-acre farm at St. Ives, Huntingdon, was made by Mr. Fred Hiam, of Cambridge. The national importance of the scheme was recognised by the Development Commissioners, who have provided a grant on the 1*l.* for 1*l.* basis.

The director of the institute, Mr. W. H. Parker, was appointed in April, 1920. Prof. R. H. Biffen, the director of the Plant Breeding Institute at Cambridge University, is one of the vice-presidents of the institute, and works in the closest co-operation with it.

The institute's headquarters buildings have only recently been completed, and were formally opened by Sir Lawrence Weaver on Friday, October 7. They are situated in Huntingdon Road, Cambridge, about 1½ miles from the town, and were designed by Mr. P. Morley Horder. The thirty acres surrounding the buildings will be utilised as a trial ground. In addition to this, the institute owns the Hiam Farm, St. Ives, Huntingdonshire, referred to above, and a farmhouse and 39 acres of good market land at Ormskirk, Lancashire, which are used as the Potato Testing Station.

The work of the institute is divided into three main branches:—

(*a*) *The Crop Improvement Branch.*—The improvement of farm crops will be achieved by the testing of promising new and re-selected varieties of all kinds of plants of the farm which may be handed to the institute by the Plant Breeding Institute of Cambridge University, other similar organisations, and individual plant-breeders, the multiplication of those stocks which have shown the best results as to yield and quality, and the subsequent marketing through existing trade channels of those varieties which, after further close observation, are approved by the institute. The growing-on of the new varieties to a commercial scale will be undertaken at the Hiam Farm, St. Ives, and also by contract with farmers in different parts of the country.

(*b*) *The Official Seed Testing Station for England and Wales.*—The administration of the English Official Seed Testing Station has been delegated to the institute by the Ministry of Agriculture. The greater part of the headquarters buildings at Cambridge is now occupied by the Seed Testing Station, which had hitherto—since its formation—been inadequately housed in temporary premises in London. The station is now the largest and best-planned in the world.

(*c*) *The Potato Testing Station.*—The institute carries out at its Ormskirk station the highly important potato immunity trials, which establish the immunity or otherwise of different varieties of potatoes from the great scourge of wart disease. This work is delegated to it by the Ministry of Agriculture, but the institute also holds trials to establish the time of maturity, yield, and quality of potatoes.

Synonymity in potato varieties has long been a source of loss and confusion to potato producers and merchants. The synonym committee of the institute, consisting of experts both scientific and practical, makes an annual report which declares which of the varieties entered for the immunity trials under new and distinct names prove to be identical with varieties already in the market.

During their visit the King and Queen were able to see the normal work of the Official Seed Testing Station at progress in most of the laboratories. The exhibits of cereals and potatoes arranged in two of the laboratories enabled the visitors to realise the scope of the other branches of the institute's work. Their Majesties were keenly interested in everything that was shown to them, inquiring minutely into the processes of seed-testing, and paying special attention to the methods of potato-breeding and the measures taken to check the spread of wart disease. At the close of their visit they expressed to Sir Lawrence Weaver their complete satisfaction with all that they had seen and their admiration of Mr. Horder's planning of the buildings and the arrangements made to secure the efficiency and comfort of the staff.

Chemical Reactivity and the Quantum Theory.

By Dr. Eric K. Rideal.

The recent discussion held by the Faraday Society on modern developments in the theories of catalytic chemistry gave rise to an important debate concerning what has been termed the radiation theory of chemical action. It is now almost generally accepted, both by the protagonists and by some of the opponents of this theory, that molecules of the same species in a reacting system may differ from one another in what is termed chemical "activity." Thus in a mixture of hydrogen and oxygen a certain fraction, both of the hydrogen and of the oxygen molecules, are "active." Collision between active molecules of the two species results in chemical combination; collision between inactive molecules produces no chemical change.

It is further argued by the supporters of the theory that true monomolecular chemical reactions exist, *e.g.* the conversion of allotropes, the dissociation of a diatomic gas, or the decomposition of substances like phosphine or ammonia; consequently, as pointed out by Perrin, "active" molecules must exist *per se,* and reaction is not the result of a particular kind of directive collision, or, indeed, of a collision taking place at some particular phase of the molecular vibration; the decomposition of phosphine thus finds an analogy in the disruption of radium.

Granting that this assumption is correct, attention has to be directed to the source of energy of activation. The opponents of the theory, who go as far as to admit the validity of the first postulate, affirm that this energy resides within the molecule itself, and may possibly be identified with the "null punkt" energy at absolute zero.

The supporters of the radiation theory adopt the hypothesis that the energy of activation is acquired from the circumambient radiation, and that in consequence all reactions are in the broadest sense of the term photochemical. The energy supplied to one molecule so as to make it "active" to undergo the given reaction, whether it be explosion or combination with another active molecule, is assumed to be supplied by radiation of a particular frequency, and in amount equal to $h\nu$, where h is Planck's constant.

For all the ordinary chemical reactions the amount of energy of activation to be supplied, as calculated by application of the fundamental equation of Arrhenius to the temperature coefficient of the reaction, is sufficiently small as to permit of the utilisation of quanta in the infra-red portion of the spectrum; for some reactions, however, visible or ultra-violet light will be necessary, whilst for accelerating the rate of change of radio-active decomposition ultra-X-rays would be required.

The equation of Wien on radiation intensity, and of Arrhenius on the temperature coefficient of chemical reactions bear a formal resemblance to one another, and it is not doubted that the same fundamental properties of matter and of radiation account for the similarity. It is further admitted that the quantum theory of Planck, applied by Bohr to the internal structure of the atom, is likewise valid in many physical and chemical operations, such as calculation of the latent heats of change of state, the heats of formation of chemical compounds, including heats of ionisation and the photoelectric effect. More recently the quantum theory has been applied with success to a general study of reaction kinetics, and it is now evident that there is no essential difference between a typical monomolecular chemical reaction, such as the decomposition of phosphine, and a physical reaction like evaporation. It cannot be doubted that both physical and chemical forces are identical in their nature and also in their mode of action.

The opponents of the theory admit these premises, but see no reason to assign to radiation the important *rôle* given to it by its adherents, and prefer to attribute the two phenomena to some common, but as yet unknown, property, giving rise to these apparent similarities.

The supporters of the theory point out that in fact many photochemical reactions do exist, and, thus admitting the possibility of the direct action of radiation on matter in causing both physical and chemical change, there is no reason why this property should not be universal.

In the development of the theory in its quantitative aspects, however, certain difficulties have arisen necessitating a modification of the simple theory originally proposed; thus the rate of decomposition of phosphine has been accurately determined over a wide range of temperature, the frequency of the radiation necessary to bring about its decomposition calculated from the reaction temperature coefficient, and the amount of energy flowing into the reaction chamber per c.c. per second at the observed temperature calculated from Planck's law. It has been found that there is not enough energy supplied by radiation to account for all the explosions actually observed.

To account for this serious discrepancy several hypotheses may be advanced. Thus we may assume that during the explosion of one phosphine molecule, which has already been activated by the absorption of one quantum of radiant energy, energy is radiated and absorbed by another molecule or by other molecules. Since it is not permissible to assume absorption in fractions of a quantum, it is necessary to adopt an hypothesis of activation of the phosphine molecule by a number of smaller quanta (infra-red) instead of one big quantum; this in turn seriously affects the logic of the deduction of the energy of activation from the temperature coefficient of the reaction.

Again, we may assume that when there is a continuous drain on one portion of the spectrum by absorption of the light of one particular frequency, the rest of the spectrum undergoes a continuous redistribution of the energy involving an increase in the absorbed radiation density and a decrease in the density of the radiation of greater and smaller wavelength. To account for such an hypothesis we must assume that there is some mechanism for the absorption of these rays in order to effect the redistribution, the purely monochromatic character of the reaction being thus lost, and a parallelism between these thermo- and photo-chemical reactions no longer exists. It is, of course, evident that such a redistribution of the energy does not take place when a reaction is illumined with ordinary visible light, since definite absorption bands are noted, and the rest of the energy either passes through the reaction chamber or is scattered from the molecule surfaces. A third hypothesis involves the assumption that the radiation density inside the actual molecules themselves is the important factor, and one which is greatly influenced by the refractive index of the molecule; computations on these lines lead to high values for the refractive index of the region inside the molecules which await other independent confirmation.

A second difficulty has been raised by a study of hydrolytic operations, *e.g.* sucrose; the temperature coefficient of the reaction indicates an activating frequency in the infra-red portion of the spectrum. Illumination with bright sunlight should cause a very great increase in the reaction velocity; no perceptible effect is actually observed. It is, however, possible to attribute the comparative inertness of these reactions to the strongly absorbent character of the environment to light of long wave length; and it has been suggested that a study of the reaction velocity in thin films under illumination might lead to positive results.

Of significance is the fact that the substance for which the activating frequency has been calculated from the temperature coefficient frequently shows no absorption band in that region. If the hypothesis be adopted that the activating frequency calculated in this manner is only a mean value, *i.e.* the possibility of activation in stages be envisaged, we are confronted with a difficulty in calculating the reverse operation, viz. the reaction velocity from a knowledge of the complete spectrum of the reacting system, since we have no information as to the manner of the distribution of the partially activated molecules.

The debate served clearly to emphasise the relationship of the quantum hypothesis to chemical action, and the fact that the radiation theory was not entirely convincing, but, on the other hand, it certainly contains the germ of the solution to the problem of the mechanism of the interaction of matter and radiation.

The Teaching of Geography.

IN opening the discussion on the teaching of geography at a joint meeting of the Sections of Geography and Education of the British Association at Edinburgh on September 9, Mr. G. G. Chisholm laid stress on the physical basis of geography, but urged the importance of regarding the physical agencies not so much as changing the face of Nature as influencing the distribution of man and his activities. Mr. Chisholm pointed out that geographers have now reached a considerable measure of agreement in the work included under the head of geography. That agreement marks a step in the better recognition of geography in the educational curriculum. At a later stage in the discussion Dr. H. R. Mill dwelt on the urgent necessity of quantitative work in geographical research, and pointed out the enormous field of study which this opens.

Sir Richard Gregory spoke of the position of geography in relation to other science subjects in the school curriculum. He advocated a course of general science as more useful for a general education than the beginnings of heat and light and the laws of chemical action for pupils up to the age of sixteen. A course in geography for all pupils up to that age would at the same time provide the unifying principle for all the science work, bringing it into relation with the activities of man. After such a course it would be equally easy for pupils to specialise in mathematics, physics, chemistry, or geography. At present there tends to be a gap in geographical teaching between school and university work, because few schools have geography teachers capable of carrying the subject to a standard equivalent with the teaching in chemistry and physics.

Mr. W. H. Barker deprecated the tendency to divide studies into watertight compartments, and insisted that the teaching in geography must be given, not by the science master, but by a geography specialist who by his training is fitted to bring out the unifying influence of the subject. Geography serves to unite the two main groups of subjects, natural sciences and humanities, and therein lies its great educational value. To reunite the specialisations is the function of the geography teacher.

Some of the difficulties of getting adequate recognition of geography in the university curriculum were pointed out by Dr. Rudmose Brown. The rigid division of studies into the faculties of arts and science is only slowly breaking down, and, in consequence, geography has a fight to find its true position. The geographer has a definite outlook, and his subject is the same, no matter in which faculty it is placed. The narrow conception of science as being confined to the so-called natural sciences must give way before geography can find adequate recognition. Meanwhile, the practical result of dividing knowledge by a rigid line of demarcation is reflected in the difficult task of giving students of geography the wide outlook that the subject requires.

A plea for the value of geography in historical study was made by Prof. R. K. Hannay. He complained of the non-geographical attitude of many historians, and urged that students of history should follow courses in geography. Prof. J. W. Gregory, in emphasising the scientific basis of geography, thought that it should be included in the science faculties of universities, but did not disparage its inclusion among arts subjects. While there has been much improvement in geographical education in Scotland in recent years, the subject still suffers from neglect and failure to take its due portion in education. This is most noteworthy in secondary schools. Dr. F. Mort was hopeful of the position of geography in Scottish schools, and quoted figures to show the increased numbers taking advanced work in the subject and taught by specially trained teachers. Prof. J. A. Green regretted that much school geography was above the heads of the pupils, the teacher not in-frequently using words and ideas that bore no relation to the mental development of the children. He advocated more attention to methods of presenting the matter of geography.

Among many aspects of the subject on which Prof. P. Geddes touched was the necessity for travel, for student and teacher alike, in order to broaden the outlook and bring the study of geography into touch with realities. Geography that relied solely, or even mainly, on maps was as lifeless as anthropology which depended solely on skulls.

Centenary of McGill University, Montreal.

McGILL University of Montreal, which has just been celebrating the centenary of its foundation, has shown of late a capacity for attracting prodigious benefactions, such as may well excite the envy of less fortunate institutions even in America. A gift of 1,000,000 dollars from the Carnegie Corporation, New York, "in recognition of the noble and devoted service and sacrifice of McGill towards Canada's part in the Great War," was followed by subscriptions last year by citizens of Montreal and graduates amounting to more than 4,000,000 dollars, a grant of 1,000,000 dollars by the Quebec Provincial Government, and 1,000,000 dollars for medical education from the Rockefeller Foundation of New York. To few institutions has it been given to receive within a short space of time such magnificent tributes from such various sources.

The University was founded by the Hon. James McGill, a leading merchant of Montreal, who died in 1813. Among the principal events in its history are: the opening of the Peter Redpath Museum, 1882; opening of Royal Victoria College, founded and endowed by the late Lord Strathcona as the Women's Department of the University, 1899; opening of Macdonald College, founded and endowed by the late Sir Wm. C. Macdonald, including the School of Agriculture, School for Teachers, and School of Household Science, 1907; gifts of estates valued at 1,117,640 dollars by Sir Wm. C. Macdonald, and of 1,500,000 dollars by various donors, chiefly Montreal citizens, 1911.

Of McGill's two most important professional schools, the Medical and the Engineering, the former will itself soon be able to celebrate its centenary, its first session having been opened in the Montreal Medical Institution in November, 1824. Engineering courses were first established thirty years later. They are now organised on a system thus described by the principal, Sir Arthur Currie, in an address delivered at the Congress at Oxford last July: "Four academic sessions of formal instruction, with the accompanying laboratory, drawing-room exercises, and shop-work, alternating with three summers of practical experience in some branch or branches of the work of the student's future profession." Among recent developments in the advanced courses in chemical engineering is the provision for instruction in the technology of the paper industry, for which the Government Forests Products Research Institute, adjacent to the University, affords special facilities.

Canadian Insect Pests.

IN the Report of the Dominion Entomologist and Consulting Zoologist for the years 1917–18 the late Dr. C. G. Hewitt presents a record of much useful work carried out on behalf of the Canadian Government. During the two years under review the work of controlling the brown-tail moth in Nova Scotia and New Brunswick is regarded as satisfactory, but it is solely due to the careful scouting for, and destruction of, the winter webs during each winter. The control of several indigenous insects is being attempted by means of the introduction and dissemination of their parasites. The "mussel scale" is largely preyed upon by the predaceous mite *Hemisarcoptes malus*, and colonies of the latter have been liberated in infected orchards; the future of the experiment will be awaited with interest. The cabbage-root maggot continues to extend its ravages, and not only was the value of tarred felt-paper discs again demonstrated, but promising results were also obtained with bichloride of mercury. A remarkable and extensive outbreak of the sugar-beet webworm, *Loxostege sticticalis*, occurred in the Prairie Provinces. The millions of migrating caterpillars caused much alarm among the farmers, but, as usual, they confined their attention in the fields to weeds, and the only cultivated crops attacked were garden plants. Owing to the increasing prevalence in many parts of Canada of insects affecting livestock, special attention is now being given to these pests, in conjunction with the Health of Animals Branch of the Department of Agriculture. A joint study has been entered upon with reference to the bot-flies of horses, and many new facts have been discovered relating to their life-histories from the point of view of preventive measures. Entomologists will also be interested in the plans of an underground insectary which are appended to this report. It is hoped by such a contrivance to overcome the difficulties in conducting investigations on soil-infesting insects, particularly during the high temperature which prevails in the summer months.

University and Educational Intelligence.

CAMBRIDGE.—Dr. O. Inchley, St. John's College, has been appointed assistant to the Downing professor of medicine, and Mr. C. Warburton, Christ's College, has been re-appointed demonstrator in medical entomology.

GLASGOW.—The University Court has appointed Dr. Percy A. Hillhouse to the John Elder chair of naval architecture and marine engineering in succession to Sir John Biles, retired. Prof. Hillhouse was appointed in 1898 the first European professor of naval architecture in the Imperial University of Tokyo. Since 1907 he has been the chief naval architect to the Fairfield Co., Govan. The Court has also promoted Dr. William J. Goudie from the lectureship in heat engines in the University to the newly established James Watt chair of the theory and practice of heat engines, endowed in commemoration of the James Watt centenary by the Institution of Engineers and Shipbuilders, Glasgow. Dr. Goudie was formerly reader in the University of London.

The University Court has appointed Dr. G. W. O. Howe, head of the department of electrical standards and measurements at the National Physical Laboratory, to be the first James Watt professor of electrical engineering in the University of Glasgow. From 1909 to 1921 Prof. Howe was assistant professor of electrical engineering in the Imperial College of Science and Technology (City and Guilds), South Kensington. He is recorder of the Engineering Section of the British Association and editor of the *Radio Review*. The new chair was one of those endowed by the Institution of Shipbuilders and Engineers of Glasgow in commemoration of the James Watt centenary.

LIVERPOOL.—The University has been bequeathed the sum of 20,000*l.* by the late Mr. Richard Braithwaite, of Liverpool.

MANCHESTER.—Dr. J. K. Charlesworth has resigned the senior lectureship in geology as from December 25, 1921, upon his appointment to the chair of geology in the University of Belfast.

The following appointments have been made:—Mr. J. S. Wrigley, assistant lecturer in engineering; Dr. R. A. Webb, demonstrator in pathology; Mr. J. H. Blackaby, assistant lecturer in physics; Mr. Arthur Adamson, lecturer in physics in the faculty of technology; and Mr. H. N. Mercer, assistant lecturer in physics in the faculty of technology.

OXFORD.—The following elections and appointments have been made at Balliol College: Dr. J. W. Nicholson, lately professor of mathematics in the University of London, King's College, to a War Memorial Fellowship as tutor in mathematics and physics; Mr. A. O. Ponder, Rhodes Scholar, to a lectureship in chemistry, and Mr. C. R. Morris to a lectureship in philosophy.

SHEFFIELD.—The following appointments have been made by the Council: Mr. H. P. Lewis, assistant lecturer in geology during the absence of the professor; Mr. E. H. Eastwood, demonstrator in pathology and bacteriology in succession to Dr. N. E. Challenger; and Mr. A. J. Chappell to be assistant lecturer in mechanical engineering.

MR. L. BOLTON, winner of the 1000*l.* prize offered by the *Scientific American* for the best essay on Einstein's theory, will give two lectures on "Relativity" at Birkbeck College, Fetter Lane, E.C.4, on Mondays, October 24 and 31, at 5.30. Admission is free, without ticket.

IN connection with the paper-making classes at the Battersea Polytechnic, a film showing "The Manufacture of Newspaper in Canada—from Standing Timber to Finished Sheet," will be displayed under the auspices of the Technical Section of the Paper Makers' Association of Great Britain and Ireland on Monday next, October 24, at 7.15 p.m. Admission is free to all interested in the paper trades.

THE first Report of the British Association Committee on Training in Citizenship has been published in pamphlet form, and can be obtained from the Secretary, 10 Moreton Gardens, S.W.5 (single copies, 1*s.* each, 9*s.* per dozen, 3*l.* per hundred). The report contains the syllabus of a text-book of civics, Lord Lytton's scheme for organising regional study, notes of lessons on regional survey, and schemes for training adopted in some county council schools.

IN celebration of the four hundredth anniversary of Cambridge printing a dinner will be given by the Vice-Chancellor and the Syndics of the University Press on November 10 in the hall of Corpus Christi College. It is stated in the University Calendar that the rights of the University in connection with printing date from 1534, but the acquisition of the present site of the Press began in 1762 and the erection of the existing buildings in 1804. The building known as the Pitt Press, which faces Trumpington Street, was completed in 1832 from part of the funds raised to establish a memorial to the younger Pitt. With reference to the early date at which the University acquired printing rights, it is interesting to note that it was only in 1476, about sixty years previously, that William Caxton set up the first printing press in England, in the precincts of Westminster Abbey.

Calendar of Scientific Pioneers.

October 20, 1896. François Félix Tisserand died.—Prominent among French astronomers of last century for his researches in mathematical astronomy, Tisserand was called to the Paris Observatory by Leverrier, in 1878 succeeded to Leverrier's chair in the Academy of Sciences, and in 1892 followed Mouchez as director of the observatory. It has been said his "Traité de Mécanique Céleste" is worthy to stand beside the "Mécanique Céleste" of Laplace.

October 20, 1894. Charles Carpmael died.—A fellow of St. John's College, Cambridge, and a writer of mathematical papers, Carpmael settled in Toronto in 1872, and became head of the Canadian weather service. In 1885 he was President of the Canadian Royal Society.

October 21, 1886. Frederick Guthrie died.—Trained in England and Germany as a chemist, Guthrie turned his attention to physics, became professor at the Royal College of Science, and in 1874 took the initiative in founding the Physical Society.

October 22, 1871. Sir Roderick Impey Murchison died.—Originally a military officer, Murchison began his career as a man of science at the age of thirty. A great geological observer, his name is especially associated with the Silurian system, and with the geological survey of Russia. He foreshadowed the discovery of gold in Australia. In 1855 he succeeded De la Beche as director of the Geological Survey of Great Britain, and he was the founder of the chair of geology at Edinburgh.

October 23, 1841. Johan August Arfvedson died.—A member of the Stockholm Academy of Sciences, Arfvedson wrote much on minerals, and in 1817 discovered the metal lithium.

October 24, 1601. Tycho Brahe died.—Noble by birth and rich by inheritance, Tycho alienated his family by his devotion to astronomy, but secured the friendship of Frederick, King of Denmark, who gave him the island of Hven, and enabled him to build the most splendid observatory ever seen. Here for twenty years Tycho and his assistants observed the heavens with an accuracy hitherto unknown. From various causes, in 1597 the observatory was abandoned, and Tycho migrated to Prague, where Kepler became one of his assistants.

October 24, 1655. Pierre Gassendi died.—Theologian, philosopher, mathematician, and astronomer, Gassendi was a provost at the cathedral at Digne, and in 1645 accepted the chair of mathematics in the College Royal in Paris, where he enjoyed a European reputation. He was the first to observe a transit of Mercury.

October 24, 1873. Frederick Crace Calvert died.—An assistant to Chevreul, and afterwards a manufacturer in Manchester, Calvert carried out many chemical researches, and to him is mainly due the use of carbolic acid as a disinfectant and for therapeutic purposes.

October 24, 1892. Robert Grant died.—The author of a valuable history of physical astronomy, Grant, in 1859, succeeded Nichol as professor of astronomy at Glasgow. Among his labours was the compilation of two catalogues of stars, one published in 1883, containing 6415 stars, and the second, published in 1892, containing 2156 stars.

October 25, 1647. Evangelista Torricelli died.—The first to demonstrate the pressure of the atmosphere and the inventor of the barometer, Torricelli after the death of Galileo in 1642 became mathematician to the Grand Duke of Tuscany. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, October 3.—M. Léon Guignard in the chair.—J. **Costantin**: Alpine biology. The modifications of the fungus *Pleurotus Eryngii* produced by an Alpine climate.—A. **Rateau**: A new locking screw nut. The system described and figured is suitable only for special work in which the cost is not of first importance. It permits an adjustment of the screw to 1/240th of a turn, with an absolutely safe lock.—G. **Giraud**: Non-linear partial differential equations of the second order of the elliptical type.—M. **Drouin**: Contribution to a general study of unlimited algorithms.—O. **Cahen**: A new aerial float. The use of an evacuated rigid envelope (sheet aluminium on a wooden framework) is suggested in place of a non-rigid balloon filled with a light gas.—L. **Rodès**: Does the earth exercise an influence on the formation of sunspots?—E. **Perucca**: The Volta effect in a vacuum and in highly rarefied gases. The couples studied included Zn | Hg, Cd | Hg, Bi | Hg, and Sb | Hg, the experiments with the Zn | Hg couple being given in detail. There would appear to be a Volta effect in the absence of a superficial gas layer, −0·17 volt for Zn | Hg. Water vapour exerts no special influence on the voltages, but the effect of oxygen, even when dry, is very marked.—M. **Curie**: The action of the infrared rays on phosphorescence. According to a recent theory of Ives and Lukiesh, there should be a diminution in the intensity of the X-rays reflected from the 110-face of a crystal of cubic blende when infra-red radiation is allowed to fall on the face of the crystal. The experiment has been made by the author, with a negative result.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 8, August, 1920.—G. P. **Merrill**: On chondrules and chondritic structure in meteorites. A study with detailed bibliography discussing the nature and origin of the chondrule.—A. A. **Michelson**: The vertical interferometer. The vertical interferometer is designed to obviate the difficulties of maintaining parallelism of the moving mirror.—A. A. **Michelson**: On the application of interference methods to astronomical measurements. A report on the determination of the orbit of Capella.—A. A. **Michelson**: A modification of the revolving mirror method for measuring the velocity of light.—W. **Duane** and W. **Stenström**: On the K series of X-rays. Data are provided for testing the following: (*a*) The existence of a third line in the α-group; (*b*) the separation of the critical adsorption from the line of shortest wave-length in the emission spectrum, namely, the γ-line; (*c*) the experimental and theoretical relations between the various lines in the K, L, M, etc., series; (*d*) the relative intensities of the emission lines; and (*e*) the equations for the wave-lengths that may be deduced from theories of the structure of atoms and the mechanism of radiation.—H. **Shapley** and Helen N. **Davis**: Studies of magnitude in star clusters, XII. Summary of a photometric investigation of the globular system Messier 3.—F. **Boas**: The influence of environment upon development. A discussion of several series of observations resulting apparently in a confirmation of the conclusion that environmental conditions play an important part in the determination of the bodily form of the adult.—R. H. **Goddard**: The possibilities of the rocket in weather forecasting. A discussion of the rocket as a means of realising the conditions desirable for obtaining high altitude data, and the extent to which the conditions necessary for a satisfactory rocket method have been realised.—C. **Barus**: Note on a pneumatic method of measuring variations of the acceleration of gravity.—C. **Barus**: Note on torsional measurement of variations of the acceleration of gravity by interference methods.—D. H. **Campbell**: The genus Botrychium and its relationships.

Books Received.

The Fixation of Atmospheric Nitrogen. By Dr. J. Knox. (Chemical Monographs.) Second edition. Pp. vii+124. (London: Gurney and Jackson.) 4*s*. net.

Rocks and Fossils and How to Identify Them. By J. H. Crabtree. Pp. 63. (London: The Epworth Press.) 1*s*. 9*d*. net.

Notes on Inorganic Chemistry for First-Year University Students. By Prof. F. Francis. Pp. viii+244. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall and Co., Ltd.) 8*s*. 6*d*. net.

Australasian Antarctic Expedition, 1911–14, under the Leadership of Sir Douglas Mawson. Scientific Reports. Series C: Zoology and Botany. Vol. 6, Part 3: Polychæta. By Dr. W. B. Benham. Pp. 128+plates 5–10. (Sydney: Government Printing Office.) 12*s*.

Selected Poems in Somerset Dialect. (The Somerset Folk Series, No. 1.) Pp. 99. (London: Somerset Folk Press.) 1*s*. 6*d*. net.

A Practical Handbook of British Birds. Edited by H. F. Witherby. Part 12. Pp. 257–352. (London: H. F. and G. Witherby.) 4*s*. 6*d*. net.

Publications of the University of Manchester: Economic Series, No. 16. Bleaching: Being a *Résumé* of the Important Researches on the Industry Published during the Years 1908–20. By S. H. Higgins. Pp. vii+137. (Manchester: University Press; London: Longmans, Green and Co.) 10*s*. 6*d*. net.

Fifty Years of Electricity: The Memories of an Electrical Engineer. By Prof. J. A. Fleming. Pp. xi+371+plates. (London: Wireless Press, Ltd.) 30*s*. net.

The Riddle of the Rhine: Chemical Strategy in Peace and War. By Victor Lefebure. Pp. 279. (London: W. Collins, Sons and Co., Ltd.) 10*s*. 6*d*. net.

Shooting Trips in Europe and Algeria: Being a Record of Sport in the Alps, Pyrenees, Norway, Sweden, Corsica, and Algeria. By H. P. Highton. Pp. 237. (London: H. F. and G. Witherby.) 16*s*.

A History of the Whale Fisheries: From the Basque Fisheries of the Tenth Century to the Hunting of the Finner Whale of the Present Date. By Dr. J. T. Jenkins. Pp. 336. (London: H. F. and G. Witherby.) 18*s*.

An Introduction to Organic Chemistry. By D. Ll. Hammick. Pp. viii+258. (London: G. Bell and Sons, Ltd.) 6*s*.

An Inquiry into the Nature and Causes of the Wealth of Nations By Dr. Adam Smith. (Bohn's Standard Library.) Reprinted from the sixth edition. Vol. 1. Pp. xxxvi+502. Vol. 2. Pp. vi+552. (London: G. Bell and Sons, Ltd.) 2 vols., 12*s*. net.

Plane Geometry: Practical and Theoretical *Pari Passu*. By V. Le Neve Foster. (Mathematical Series for Schools and Colleges.) Vol 1. Pp. xi+229+xi. Vol. 2. Pp. xii+229–423+xi. (London: G. Bell and Sons, Ltd.) 3*s*. each vol.

Botany for Students of Medicine and Pharmacy. By Prof. F. E. Fritch and Dr. E. J. Salisbury. Pp. xiv+357. (London: G. Bell and Sons, Ltd.) 10*s*. 6*d*. net.

The Psychology of Thought and Feeling: A Conservative Interpretation of Results in Modern Psychology. By Dr. C. Platt. Pp. x+290. (London: Kegan Paul and Co., Ltd.) 7s. 6d. net.

A History of British Mammals. By G. E. H. Barrett-Hamilton and M. A. C. Hinton. Part 21. Pp. 697–748+plates. (London: Gurney and Jackson.) 3s. 6d. net.

Cane Sugar: A Text-book on the Agriculture of the Sugar Cane, the Manufacture of Cane Sugar, and the Analysis of Sugar-House Products. By Noel Deerr. Second (revised and enlarged) edition. Pp. viii+644+29 plates. (London: Norman Rodger.) 42s. net.

Diary of Societies.

THURSDAY, OCTOBER 20.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—G. Brewer: The Langley Machine and the Hammondsport Trials.

CHEMICAL SOCIETY, at 8.—R. L. Grant and F. L. Pyman: Nitro- and Amino-derivatives of 4-Phenylglyoxaline.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Commercial Vehicle and Motor Car and Marine Exhibitions, Olympia).—T. Clarkson: Coke as a Fuel for Commercial Vehicles.—W. D. Williamson: Leading Devices for Commercial Vehicles.

FRIDAY, OCTOBER 21.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Presidential Address by Dr. Logan Turner: The Structural Type of the Mastoid Process based upon the Skiagraphic Examination of 1000 Crania of Various Races of Mankind.—Dr. Watson-Williams and E. Watson-Williams: A Method of Diagnostic Exploration of the Posterior Ethmoidal Cells.——(Electro-Therapeutics Section), at 8.30.—Presidential Address by Dr. E. P. Cumberbatch: Progress in Electrology and Radiology: The Importance of Physics, Physiology, and Anatomy.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science, South Kensington), at 5.—S. Butterworth: (1) On the Use of Anderson's Bridge for the Measurement of the Variations with Frequency of the Capacity and Effective Resistance of a Condenser. (2) The Elimination of Earth Capacity Effects in Alternating Current Bridges.—F. G. H. Lewis: An Automatic Voltage Regulator.—Prof. A. S. Hommy The Flow of Viscous Liquids through Slightly Conical Tubes.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. W. Rosenhain, S. L. Archbutt, and Dr. D. Hanson: Eleventh Report to the Alloys Research Committee on Some Alloys of Aluminium.

MONDAY, OCTOBER 24.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—R. E. Light: The Efficient Utilisation of Steam and Electric Power in Factories.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Presidential Address by Mr. M. Hopson.—J. B. Parfitt: The Treatment of Pulpless Teeth.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Archibald Garrod, and Others: Discussion on the Modern Treatment of Diabetes.

TUESDAY, OCTOBER 25.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. W. W. Payne and Dr. E. F. Poulton: Epigastric Pain.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—T. F. McIlwraith: The Influence of Egypt on African Death Ceremonies.

SOCIOLOGICAL SOCIETY, at 8.15.—R. Unwin: Preparations for the General Adoption of Town Planning.

WEDNESDAY, OCTOBER 26.

ST. MARY'S HOSPITAL MEDICAL SOCIETY, at 8.—Dr. C. Singer: Leonardo Da Vinci as a Man of Science and Anatomist.

THURSDAY, OCTOBER 27.

INSTITUTION OF MINING AND METALLURGY (at Geological Society's Rooms), at 5.30.—L. Hill: Ventilation and Human Efficiency.—J. N. Justice: Notes on the Ore Deposits of Eagle Mountain, Demerara.

CHILD-STUDY SOCIETY (at Birkbeck College), at 6.—Discussion on Individual Training in the School.—Miss Bassett: The Dalton Plan.—Miss Mackinder: Individual Work.—Mrs. Bottrill: Vertical Classification.

EGYPT EXPLORATION SOCIETY (at Royal Society Rooms), at 8.30.—P. E. Newberry: Early Relations of Egypt, Babylonia, and Syria.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Presidential Address by Sir Thomas Horder: The Medical Aspect of Some Urinary Diseases.

FRIDAY, OCTOBER 28.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Continuation of Discussion on the Eleventh Report of the Alloys Research Committee on Some Alloys of Aluminium.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Presentation of Jenner Medal to Sir Shirley Murphy by the President.—Dr. L. G. Haydon: Plague in Wild Rodents in South Africa.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a course.*)

THURSDAY, OCTOBER 20.

UNIVERSITY COLLEGE, at 4.—Dr. T. G. Pinches: Babylonian Magic (3).

FRIDAY, OCTOBER 21.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (2).

MONDAY, OCTOBER 24.

BIRKBECK COLLEGE, at 5.30.—L. Bolton: Relativity (1).

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (1).

TUESDAY, OCTOBER 25.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (3).—The Statistical Character of the Laws of Nature.—Dr. W. Brown: Psychology and Psychotherapy (2).—L. J. Hunt: Cascade Synchronous Motors and Generators (2).

WEDNESDAY, OCTOBER 26.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss A. Werner: Bantu Tribes of East Africa (2). At 5.—Rev. W. Hopkyn Rees: Chinese Folk Lore.

KING'S COLLEGE, at 4.30.—Dr. C. A. Da Fano: Histology of the Nervous System (3).—At 5.15.—Prof. W. T. Gordon: Geological and Geographical Physical Basis of the British Empire.

THURSDAY, OCTOBER 27.

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (2).

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