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The Highway to the University.[1]

THE report on the accessibility of university education to poor students prepared by Mr. G. S. M. Ellis for the Stapley Trust, for which Lord Haldane has written an appreciative foreword, reopens an ancient controversy on a basis of modern needs. The author's case, reduced to its bare bones, is that the percentage of the population of England educated at a university is far behind that of Scotland or Wales; that the wider opportunities in Wales and Scotland are reflected in the larger numbers of pupils from elementary schools who reach the university; and that the scholarships offered by local education authorities in aid of university education in England are inadequate in number and, on the average, insufficient in amount.

The remedy proposed is that a uniform minimum provision of university scholarships should be made a statutory obligation on all local education authorities. Incidentally, the author criticises severely the Board of Education for neglecting to bring up-to-date statistics of scholarships such as were supplied for 1911–12 to the Royal Commission on the Civil Service, and published in 1914. The author apparently had not seen, before his booklet went through the press, the recently published Statement of Expenditure on Maintenance Allowance Awards incurred by local education authorities in 1923–24 (Cmd. 2415). It would have warned him of the unreliability of any conclusions drawn from the figures of 1911–12 being applicable to the conditions of 1924–25. The limitation also of the report to one—though no doubt the largest—source of supply of scholarships, namely, those offered by local education authorities, makes impossible any kind of estimate of the adequacy or inadequacy of the supply as a whole. A general review, however, is a task for the Board of Education, and not for an individual worker. The most valuable part of the author's case is that he has shown the pressing need for such a survey.

Mr. Ellis calculates that 21 per 10,000 of the Scottish population were full-time university students in 1922–1923, the figures for Wales and England being 12 and 8 respectively. The actual numbers were 27,994 (England), 2650 (Wales), and 10,294 (Scotland). It is long since Scotland acquired the university-going habit. It was the outcome in the past of the excellence of her parish schools, of inexpensive university education, of the inducement of hundreds of small university bursaries, of parental sacrifice, and, above all, of the fact that to poor and able Scottish youths the university became the gateway to the world. In more recent days, the extended provision of secondary school education

[1] "The Poor Student and the University." By G. S. M. Ellis. Pp. xi +60. (London: The Labour Publishing Co., Ltd., 1925.) 2s. 6d. net.

and assistance from the Carnegie Fund, have strengthened the traditions of earlier generations. A telling example comes from the Hebrides. The island of Lewis has a population of 28,000 persons, 4000 of them in the town of Stornoway. In 1894 the Nicolson Institute in that town was a small elementary school of 256 pupils with a handful of ex-standard children included. The newly appointed headmaster organised a secondary course, and a few school bursaries were made available from county funds to bring in the landward children. Four years later the school sent its first two students direct to the university.

The same headmaster, about to retire, reports a roll of 400 secondary school pupils (half from country districts), and that in the interval the school has sent 250 boys to the university and 240 girls to training colleges for teachers. These students were the sons and daughters of townsmen, crofters, and fishermen, with here and there one from the schoolhouse or the manse. The maintenance bursaries at the school vary from 5*l.* to 24*l.* About 180 country pupils are living in lodgings. That number includes 50 girls in the hostel provided three years ago by the Carnegie United Kingdom Trust (charge, 12*s.* per week). The county (university) bursaries, in any individual case, do not exceed 30*l.*, to which may be added the Carnegie fees grant of 9*l.* A few of these scholars hold in addition a small bursary from the Highland Trust or other granting body. The balance of the cost is made up in many cases with much effort and self-denial on the part of parents, brothers, and sisters. It is often a family concern, with uncles and aunts and cousins also helping. The old students of that school are so much scattered over the globe that a much-travelled Scot who has an intimate knowledge of it said recently that the island of Lewis was the most cosmopolitan rural area in Great Britain.

Until two generations ago, higher education in England was the privilege of the middle and upper classes. But the progress made in the present century has been remarkable. By the end of last century the School Boards had done their work of providing elementary schools and getting the children into them. The Education Acts of 1902–3 empowered the new authorities to supply or aid higher education and to organise a system by means of which pupils might pass from the elementary schools to the secondary, and from these to the university. In 1904–5 there were 95,000 pupils in secondary schools in England and Wales: twenty years later the number in schools on the grant list had risen to 359,000. Since 1914 the figures have been doubled. The Board of Education estimates (Report, 1923–24) that in 1900, 5500 children were being assisted to proceed from elementary to secondary schools; to-day the free places in secondary schools on the grant list number 110,000, 36 per cent. of the total. Moreover, the school life is lengthening; the proportion of pupils above eighteen years of age is steadily growing, and the candidates for the higher school certificate examinations are increasing annually at a great pace. In the present year the number reached 5000: six years ago it was only 2000. The number of university scholarships awarded in 1911–12 was 464, the total maintained at universities in that year being 1327, the average value 43*l.*, and the total 57,000*l.* Mr. Trevelyan stated in the House of Commons in April 1924 that in the year 1922–23 the local education authorities had expended 220,000*l.* in scholarships to universities and other institutions of university rank. We now learn from the Statement of Expenditure (Cmd. 2415) incurred by local education authorities in maintenance allowances under Grant Regulations No. 14, that allowances of 127,000*l.* were made to undergraduates in 1923–24, the number of awards being 2756, while other awards to technical colleges and other institutions of university rank amounted to 81,594*l.* Lastly, whereas in 1908–9 695 boys and 361 girls proceeded to a university from grant-earning schools in England and Wales, by 1920–21 the numbers had risen to 1674 boys and 1214 girls, nearly three times as many. In the former year one-third of the schools contributed; in the latter, two-thirds.

This array of figures does not prove that the number and value of scholarships in 1924–25 are greater than they were in 1911–12. But it does suggest with certainty that a profound change has been effected, and that it would be unwise to frame any policy on figures so completely out-of-date as those of 1911–12. The splendid record of the progressive authorities must not, however, be allowed to hide the parsimonious attitude of a good many others whose contributions to university education are nil or negligible. In this connexion, one of Mr. Ellis's subsidiary points deserves greater attention than it usually gets: the possibility of higher education has come to depend overmuch on accidents of birthplace and residence, and the exact position of the county or borough boundary has assumed a fortuitous and unreasonable importance.

Space forbids much further consideration of this very interesting pamphlet. "Obviously," says the author, "the provision of scholarships does not meet the national need for trained men and women." Again, "it would be difficult to maintain that only this small percentage (0·73) of elementary school boys and girls who reach the university has outstanding ability." The crux of the problem is the bringing together of ability and opportunity. The concern in the homes of poor students is with the opportunities that follow a

university course. Here is a task for the Appointments Boards, which have already done much to facilitate the process of getting graduates placed. When conditions become such that a high percentage of honours graduates has little difficulty in obtaining posts with reasonable prospects, the story of such successes will soon reach the schools, and there will be no lack of graduates of "outstanding ability." The desire to reach the university will then react on the scholarship system and help to expand it.

The road to the university is not, however, the only outlet to the poor student. Among others, some attention might have been given to the technical colleges which provide full-time three-year courses for 4500 students.

Radioactivity and Geology.

The Surface-History of the Earth. By Dr. John Joly. Pp. 192 + 9 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 8*s.* 6*d.* net.

IN this brilliant and stimulating book, Prof. Joly has conveniently brought together the results of many years' work and thought on the radioactivity of the rocks. Its central theme is an illuminating hypothesis, according to which the radioactivity of the rocks has been the dominant influence in controlling geological history. The search for adequate causes and convincing explanations is beginning to be rewarded, and theoretical geology need no longer grope in a maze, albeit a fascinating one, of unco-ordinated observations. Prof. Joly's inspired originality should henceforward lead geology into a new phase, the more mature phase that lies beyond the initial observations and their classification.

The present Lord Rayleigh's pioneer work on the distribution of radium in rocks showed nearly twenty years ago that the earth must gain from radiothermal energy at least as much heat as it is losing by radiation into space. It was difficult, indeed, to believe that the earth was not actually growing hotter. In 1921 Lord Rayleigh again expressed the guarded opinion that the internal temperatures should be rising, but he added, "we are puzzled to explain the existing state of things" (NATURE, October 27, 1921, p. 280). In 1915 the present writer elaborated a cooling hypothesis that has since been widely adopted, involving a distribution of the radioactive elements that permitted the earth to have cooled from a molten state since the beginning of geological time, and allowed for internal temperatures that were thought to be adequate to explain vulcanism. Further consideration of the implications of this hypothesis have led to its abandonment for the sufficient reason that they were found to be in contradiction with the known facts of geological history. It should be said, however, that Dr. Harold Jeffreys still considers that any departure from this hypothesis in the direction of admitting more radioactivity leads to consequences that flatly disagree with observations. Apparently it is as impossible to believe that the earth is cooling as it is to believe that the earth is not cooling.

A way out of the impasse has been found by Prof. Joly. He persuades us to believe that both heating and cooling have taken place. There would be a touch of Irish humour here, were it not that the two processes do not occur at the same time. They alternate; and in the alternation lies a clue to the cause of the mysterious heavings and crumplings that have periodically affected the outer shell of the earth.

From the known data of seismology, and the well-established theory of isostasy, Prof. Joly concludes that the continents are essentially composed of granitic rocks having a thickness of about 32 km., and a density of about 2·67; and further, that they are submerged in a deep substratum of basaltic composition which rises around them to form the ocean floor, and has a density when solid of about 3·0. The materials of the continents and the substratum respectively are supposed to contain substantially the same proportions of the radio-elements as actual specimens of them, represented by granites and basalts from various parts of the globe. From the data adopted, and there seems here to be no possible flaw, the temperature at the base of the continents is easily calculated to be approximately that of the fusion-point of basalt, while the heat emitted is equivalent to that lost from the surface of the lands by radiation. It follows from this that the heat generated in the underlying basaltic layer by the radio-elements must accumulate; and since the substratum is solid at the present day, it evidently lacks only latent heat to become fluid. In about forty million years it must become so throughout. Similarly, at and below a certain depth beneath the ocean floor, the substratum must also pass sooner or later into a fluid condition.

Geological time is to be measured in at least hundreds of millions of years, and consequently this accumulation of latent heat in basalt must have occurred in the past; and as the substratum is now solid, the excess of heat must in some way have been dissipated. Tidal action is ingeniously invoked to provide a mechanism whereby the accumulated heat can be for the most part harmlessly discharged into the oceans. When widespread fusion supervenes, a slow westerly drift of the still solid crust begins, and the deep, possibly superheated magma formed beneath a continent thus comes to underlie the ocean floor to the east. The ocean floor is then stoped and melted away from below, until the upward loss of heat by conduction becomes sufficiently rapid to bring

the process to an end. Widespread consolidation is promoted by convection currents, and owing to the sinking of stoped-down blocks and newly formed crystals, solidification develops from below upwards. Finally, the lateral movement is brought to a standstill by the grounding of the continental roots on a solid foundation. Each level of the substratum is thus left at the end of the cycle at a temperature that must be that of its solidifying point, or a little lower, at the pressure there obtaining.

Tectonic and igneous processes are obviously facilitated by the changing volume and changing state of the substratum. The overlying crust becomes heaved up as fusion progresses, but the continents sink a little relatively to the oceans, and transgressional seas advance over the lands. Continents and ocean floor are now under tension, and basaltic magma squeezes through the cracks, healing the ocean floor and preventing its wholesale subsidence into the depths, and giving rise to vulcanism on a large scale such as broke out in early Tertiary times in the Deccan and Brito-Arctic provinces. Present-day vulcanism is of a different nature altogether, being a consequence of the ascent of hot gases from magmas now in the later stages of crystallisation.

When the expansion due to the growth of the magma is at its maximum, the area of the surface is greatly increased, and when consolidation sets in, the increased area has to settle down on the contracting substratum. Where the margins of the continents have been weakened by the filling of bordering geosynclines with sediment, they become deformed by folding and overthrusting due to the resulting compression. The seas withdraw as the lands begin to rise again, and finally isostatic adjustments complete the orogenic processes, and the newly folded mountains rise in proportion to the depths of their roots.

In broad outline, the ideal cycle of events thus briefly sketched can be matched several times over by the actual sequence of events in geological history. In detail, a simple repetition of the cycle is quantitatively insufficient. Prof. Joly acknowledges only three complete cycles since the Charnian orogenesis of the late pre-Cambrian, terminating in turn in the Caledonian, Hercynian, and Alpine movements. The Laramide of America is thought perhaps to imply a fourth. The writer has found that the evidence suggests a list of five times as many cycles since the pre-Cambrian; some involving merely subsidence and emergence; others being accompanied by moderate folding; and a few, the great "revolutions" of Prof. Joly, being marked by overthrusting to a degree that would be mechanically incredible had it not indubitably occurred. Such a striking variation in intensity seems to imply not only the expansion and contraction of the basaltic layer alone, but also the superimposed effects of underlying layers which may reasonably be expected to be less radioactive.

The different interpretation to which attention is here directed may be tested with reference to geological time. It is well known that Prof. Joly favours the smaller estimates of time, such as that based upon the supply of sodium to the oceans. He also believes from the evidence of pleochroic haloes that uranium may have disintegrated very much more rapidly in the past, and for this reason that certain thorium minerals may give more reliable lead-ratios than uraninites. The chapter in which these matters are dealt with is distinctly provocative and certainly unsatisfactory. The sodium method has really no bearing on the question at all, for the data that have been employed are both faulty in themselves and contradictory in their implications. Some thorium minerals (such as the thorianites of Ceylon) give the same lead-ratios as the associated uranium minerals, and it seems unfair to pick out the smaller results as being better than the larger. The atomic weight of lead from radioactive minerals definitely suggests that uranium has decayed at the same or nearly the same rate throughout geological time. The anomalies of pleochroic haloes can be explained in at least two other ways besides the one favoured by Prof. Joly, and all three must remain speculative until we know more of the complexity of "uranium" and the origin of actinium. The reviewer can find no reason to believe that the lead-ratios of uranium minerals may be "four times too high." At the worst it is improbable that they should be in error by more than 10 per cent.

Prof. Joly's application of his hypothesis to earth movements implies three or four cycles of about 40 million years each, giving only 120 or 160 million years since the beginning of the Cambrian. But if the actual length of time is of the order 600 million years, as indicated by radioactive minerals, then there should have been many more cycles, as indeed there have. The more prominent mountain-building periods would then be due to the superimposed effects of the consolidation of a deeper-seated magma, such as that of peridotite. This presumably has gone through only a few cycles, each being of much longer period than those of the comparatively shallow basaltic substratum.

It must not be supposed that this difference of opinion in a matter of interpretation is intended to detract in any way from the value of Prof. Joly's far-reaching hypothesis. On the contrary, it illustrates in a remarkable way the fertility and all-embracing character of that hypothesis. Logically extended, and applied on a more detailed scale to the geological history it is

intended to elucidate, a still stronger case can be made out in its favour. Moreover, it renews interest in the principles of Wegener's displacement theory, for this can no longer be resisted on the grounds of permanent rigidity. It raises a substantial hope that in the lateral movements of the crust a solution may be found of the tantalising problems of the climates of the past. In the domain of igneous petrology it will prove invaluable by providing for the first time the possibility of a real genealogy of rocks. Already it has so much to its credit that it must be regarded as a contribution to geology of the highest rank.

The thorough assimilation of the contents of this book by all geologists is indispensable, and indeed every one who is at all interested in the behaviour of the earth should read it. The lucid style reveals the author at his best, and the book is easily readable, for technical matters of detail are relegated to the appendices that close many of the chapters. Finally, a word of praise is due to the publishers. They have made a book that is worthy of its subject and its author, beautifully printed and illustrated, and issued at a price which can only mean that they wished to encourage every geologist in the world to buy it.

ARTHUR HOLMES.

Electrical Precipitation: Natural and Artificial.

Electrical Precipitation: a Lecture delivered before the Institute of Physics. By Sir Oliver Lodge. (Physics in Industry, Vol. 3.) Pp. 40+5 plates. (London: Oxford University Press, 1925.) 2*s.* 6*d.* net.

CHEMISTRY has been defined as "the dirty past of physics." The electrical precipitation of dust from industrial gases, for example from producer gas, blast furnace gas and various gaseous products of chemical industry, is a dirty business. This may in part account for the fact that the subject is, so far as current English scientific literature is concerned, treated only in works on chemistry. The literature of physics is practically silent about the subject. No reference to it is found even in Glazebrook's "Dictionary of Applied Physics," and this even though the process is decidedly both applied and physical in character. This deficiency is now rectified by the appearance in book form of Sir Oliver Lodge's lecture on electrical precipitation delivered before the Institute of Physics, in which the subjects of natural and artificial precipitation of moisture, dust, etc., are discussed in a manner of which Sir Oliver almost alone would appear to possess the secret. His recent plea for a simplification of the language in which science seeks to deliver its message is here followed up by a glowing example of the manner in which this may be achieved.

The story of natural electrical precipitation as evidenced in thunderstorms is first told. In fine weather the average atmospheric positive potential gradient at the earth's surface is of the order of 100 volts per metre. The gradient diminishes with height, the potential assuming a practically constant value of about 1 million volts at a height of 10 kilometres. During a thunderstorm the vertical force at the ground frequently exceeds 10,000 volts per metre. An average flash of lightning has a length of 10 kilometres, and the energy liberated in the flash is equivalent to that acquired by a mass of 100 tons falling 650 yards.

The maintenance of the fine weather potential gradient in the atmosphere is one of the outstanding difficulties of meteorological physics. At least four theories, against each of which some objection can be sustained, have been proposed. As regards the origin of the potential gradients associated with thunderstorms, Simpson's theory proposed in 1909 is that most generally, though by no means universally, accepted. Simpson discovered the remarkable fact that the mere breaking-up of a drop by a current of air results in electrification. A large drop falling through air and breaking-up becomes positively charged, the air receiving a negative charge. Sooner or later the small ascending globules of water produced coalesce into larger drops and the cycle of operation is repeated, until the drops become so highly charged that they no longer combine and fall. They are then carried to a higher stratum and form part of an electrified cloud. This, very briefly, is Simpson's theory of the origin of a thundercloud. Prof. Armstrong, in explanation, brings in hydrone, forsooth! (NATURE, 1923, 112, 537, 827; 1924, 113, 124.) Is the hydrone theory helpful in explaining even the simplest experimental facts of electrolysis, for example, the phenomenon of visibly moving boundaries met with in the determination of "ionic velocities"?

Sir Oliver suggests that natural precipitation in the form of rain should be artificially assisted, whereby the "rain-makers" may be dispossessed of this field. We foresee trouble arising from matters relating to the degree of control to be exercised, and to the selection of one or more in whom the right to exercise this control is to be vested. Have we not heard of a Scotch divine who, on his prayer for rain being "answered" by an immediate and boisterous thunderstorm, exclaimed, "Oh, Lord, this is too ridiculous"?

A section on the precipitation of dust from gases on an industrial scale is contributed to the volume by Lionel Lodge. The idea of removing suspended particles from gas streams by means of electrical discharge would appear to have been originated by Hohlfeld in Leipzig in 1824. Guitard revived the

subject in London about twenty-five years later. Sir Oliver Lodge and Mr. J. W. Clark in 1884 investigated the dust-free space in the neighbourhood of hot bodies—a phenomenon to which is attributed the blackening of walls, ceilings, etc., in the neighbourhood of gas flames and electric light bulbs (p. 24)—and suggested the use of an electrical discharge as a means of dissipating fog and smoke. In 1885, Messrs. Walker and Hutchings, in association with Lodge, attempted the commercial exploitation of the electrical cleansing of gases. In those days the methods of producing high-tension discharges were primitive, and the difficulties of securing efficient insulation were insufficiently appreciated. The attempt was ultimately abandoned.

The subject was revived by Cottrell in 1906 and the practicability of the system definitely established. The first successful commercial plant was erected by the Selby Smelting and Lead Company at San Francisco Bay. The Lodge and Cottrell financial interests were amalgamated by the formation of Lodge-Cottrell Limited, now working in friendly co-operation with the Metallbank u. Metallurgische Ges. A.-G. The scale of the operations may be gauged by reference to the first successful plant erected at Queen's Ferry by the Ministry of Munitions in connexion with a Gaillard sulphuric acid tower. Here about 64,000 cubic feet of gas at 80° C. flow per minute past the discharge and collecting electrodes and carry about 4 grains of SO_3 per cubic foot. The operating voltage is about 100,000 volts, and about 30 tons of sulphuric acid are recovered a day.

The practical difficulties have not as yet, in all cases, been overcome. There are troubles connected with the dislodgment of the deposited dust from the electrodes. The hygroscopic character of the dust introduces difficulties in some cases; the shape of the electrodes is of paramount importance in others. The plant is necessarily on a large scale. Thus a plant erected to operate in conjunction with a number of blast furnaces was, on account of its size, popularly known as "the cathedral." Even with plant on such a scale, difficulty was experienced in purifying the gases, originally containing 5 grams of dust per cubic metre, to such a degree as to render them fit for use in gas engines. However, progress is being made, and the process is nowadays applied in a variety of directions, there being about 200 plants operating in conjunction with plants for the recovery of products from acid fumes, waste gases from metallurgical processes, combustible gases and miscellaneous dusts. The average efficiency of the plants is such that about 95 per cent. of the dust content is deposited. Cleaning costs amount on the average to about 1*s*. per 100,000 cubic feet of gas treated.

J. S. G. THOMAS.

The Art and Life of Early Man.

Prehistory: a Study of Early Cultures in Europe and the Mediterranean Basin. By M. C. Burkitt. Second edition. Pp. xxvi+438+48 plates. (Cambridge: At the University Press, 1925.) 35*s*. net.

IT is not surprising that Mr. Burkitt's treatise on prehistory should so soon have reached a second edition. It is a unique summary of the handicraft and art of the successive races of Palæolithic man in Europe, with some references to Neolithic and Bronze Age man. It is based on personal observation, guided by one of the foremost pioneers in such research, the Abbé Breuil. It is not only a clear statement of the facts in convenient order, but also a discussion of all the important inferences which may be drawn from these facts as to the life and ideas of primeval man. It is, indeed, both a work of reference and one which will satisfy the general reader who desires only a broad view of the subject.

The new edition is not much changed, only one chapter, that on "The Neolithic and Bronze Ages," having been largely rewritten. The author, however, mentions that he has taken note of various press criticisms, and he has made the book more useful by adding to the text references to the figures in the plates. He has also included a map of western Europe showing the position of the more important localities cited. The new frontispiece, representing the "sorcerer" in the cave of Trois Frères in southern France, is a striking addition. It is the figure of a man disguised by placing a stag's antlers on his head, drawn on the wall "dominating the situation beside the natural pulpit where no doubt the actual artist-medicine-man-priest performed." This and some other recent discoveries are specially mentioned in the preface prepared for this second edition.

The chief additions to the text are in short notes where space admits them at the end of each chapter. It is perhaps the simplest, but not altogether a satisfactory arrangement. The text itself still needs revision. The statement that "bone was first utilised in Upper Mousterian times" (p. 76) is contradicted by the reference to the bone implement from Piltdown (p. 89). A footnote on p. 94 has escaped notice. Some of the English construction could also be improved. The author does not mean what he says, for example, when he refers to heads which have been decapitated (p. 188); and there are other expressions which need some modification. These, however, are minor blemishes in a work which will continue to be indispensable to every student of prehistoric archæology who would keep abreast of his subject.

A. S. W.

Our Bookshelf.

(1) *Relativity; a very Elementary Exposition.* By Sir Oliver Lodge. Pp. iv+41. (London: Methuen and Co., Ltd., 1925.) 1*s.* net.

(2) *Relativity, Meaning, and Motion.* By Claude G. Henderson. Pp. vi+111. (London: Watts and Co., 1925.) 3*s.* 6*d.* net.

(3) *The Common Sense of the Theory of Relativity.* By Dr. Paul R. Heyl. Pp. 44. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1924.) 5*s.* net.

(4) *La relativité dégagée d'hypothèses métaphysiques: exposé des théories d'Einstein, discussion de ces théories, essai d'une théorie nouvelle construite dans l'espace et le temps classiques.* Par H. Varcollier. Pp. xx + 542. (Paris: Gauthier-Villars et Cie., 1925.) 50 francs.

(1) THIS short account of the theory of relativity was given as a lecture to the Literary and Philosophical Society of Liverpool in 1921. The book is—as the title states—a very elementary exposition. It is certainly hopeless to give a popular account which bears even the slightest resemblance to the theory of relativity without drawing on the concepts of ordinary life; and this essay is interesting to read because it shares with the other writings of Sir Oliver Lodge the agreeable characteristic of being filled with vivid illustrations from the everyday experience of the man in the street.

(2) Mr. Henderson's small book is designed for a popular audience, and it is unfortunately not unlike a large number of other books meant for the consumption of the general reader, in that the language and the treatment are frequently obscure. It is indeed difficult to know what useful purpose can be served by introducing the ideas of the theory of relativity into the discussion, on general non-technical lines, of questions such as "the nature of truth," "meaning," "the mind," and so on. The argument from analogy used with no regard for the niceties of problematical inference is a poor instrument.

(3) Prof. Heyl's essay on relativity breaks new ground in popular exposition. The plan is to give first a brief historical account of the development of the data relevant to the law of gravitation, and many interesting pieces of information are to be found in the opening chapters. The author gradually builds up, in the simplest language, the position of affairs before Einstein, and shows how the outstanding discrepancies were accounted for by the theory. This side of the book is good; but there is another side.

The author makes remarks, which may or may not be cryptic to the popular reader, about the "repelling appearance" of Einstein's theory and its "artificial nature," and he quotes the jejune observation that it is "repugnant to common sense."

Now it is undesirable to leave the erroneous impression in the mind of any reader that the theory of relativity is fundamentally artificial, however poor his knowledge of mathematics may be. For the nature of the postulates and the new and subtle appeal which they make to the scientifically developed common sense is the outstanding characteristic of the theory of relativity from the point of view of scientific method. The notion of an "Invariance Postulate" is perfectly simple and can be explained to any intelligent person. This is the really important idea, and is what should be emphasised if an appeal to intuition and plausibility is to be made. There should therefore be an attempt to introduce it in a book which deals with the common sense of the theory of relativity.

(4) Prof. Varcollier's interesting volume should be very stimulating to the student of modern theories of world geometry and mechanics. The work is concerned with the exposition of the mathematical structure of relativity theory and with special interpretations of the results. Whatever may be the verdict on the interpretations, the very detailed account of the mathematical groundwork of modern mechanics should prove useful. D. M. W.

Tabulae Anatomo-Comparativae Cerebri: a Series of Nine coloured Maps with Description. Edited by Dr. C. U. Ariëns Kappers. Descriptive Text. Pp. 30. Plates 44 in. × 31½ in. (Amsterdam: The "Kosmos" Publishing Co., 1925.) 20 U.S. dollars.

THE "Tabulae Anatomo-Comparativae Cerebri," edited by Dr. Ariëns Kappers, director of the Central Institute for Brain Research in Amsterdam, consist of a set of nine large coloured plates illustrating the comparative anatomy of the brain and spinal cord. Two of these charts are before us.

The central nervous systems of Acrania, cyclostomes, selachians, teleosts, amphibia, reptiles, birds, marsupials, and primates (man) are to be exemplified by those of certain carefully selected types. The different nuclei and the chief fibre systems are all so represented in different colours that the comparative arrangement of any part of the central nervous system can be recognised at a glance. As the various parts of the central system are represented in sagittal projection, the nuclei and the tracts are all reduced to one plane, and for the sake of clarity some freedom in drawing has been necessary.

The chief interest in the series centres in the evolutionary changes whereby the human brain is the outcome. It is to be made apparent that in the human brain the thalamus proper, and more especially the dorsal thalamus, have undergone striking increase, whereas the tonic and autonomic striatum has increased but slightly. The pallial centres of sensory, visual, acoustic, and olfactory projections, regarding them as a whole, have not increased so much as the centres of correlative functions, which depend not only on intercortical systems but also on connexions with subcortical nuclei. For example, the increase of the frontal is chiefly associated with the increase of rubrofrontal projections and the appearance of fronto-pontine fibres which have stereopractic functions; the increase of the parieto-occipital is associated with the stereognostic projections of the pulvinar, and is thus correlated with the recognition of external objects by means of the skin, joint, and muscle sensibility. Dr. Kappers wisely refrains from giving any anatomical explanation of the increase of the temporo-occipital region of the cortex, but hints that owing to the connexion of the occipito-temporal lobe with the red nucleus it may, in addition to its acoustio-visual correlations, be some sort of stereognostic centre.

Dr. Kappers has brought his extensive knowledge and consummate skill as a draughtsman to bear on the preparation of the plates. The results are at first sight somewhat bewildering in their complexity, but they will prove invaluable to the student and investigator of comparative neurology.

Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1918. Part 5: *Réseau Mondial, 1918. Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude.* (M.O. No. 231g.) Pp. xiii+116. (London: H.M. Stationery Office, 1925.) 21*s.* net.

THE present volume is the ninth of the series, the work now being completed for each year from 1910 to 1918. All the information refers to land stations; it has not yet been practicable to give data over the sea. The total number of stations utilised is 449, which is 9 fewer than in 1917. Stations are easily identified by a systematic numbering, maintained year after year. The majority of the stations for which information is given are under the control of government meteorological services. Wherever possible, the departures from normal of the monthly and annual values of mean pressure, mean temperature, and precipitation are given. Wind data are given for selected stations in the tropics; and there are notes on the state of the ice in the Arctic Seas and in the North Atlantic Ocean.

When data are received for another year, making a consecutive period of ten years, there will be sufficient information for many tentative inquiries, such as stable or varying barometric pressure from year to year over the whole globe, the effect and influence of normal and abnormal changes in one part of the globe on the conditions experienced elsewhere, the controlling factors being of much value for long period forecasting.

The highest mean shade temperature for 1918 was 86° F. at Berbera, Somaliland: the lowest mean 4° F. at Verkhoïansk. The absolutely highest temperature was 115° F. at Bourke, in New South Wales, on December 9: the second highest was 114° F. at Berbera on July 12, 16, and 25: the absolutely lowest was −76° F. at Verkhoïansk on February 2. The heaviest total rainfall for the year was 511 inches at Cherrapunji, which is 87 inches more than the average; 170 inches fell in June. The latter is more than seven times as heavy as the annual average fall at Greenwich. No rain fell during the year at Insalah or Iquique.

Tabulae Biologicae. Herausgegeben von C. Oppenheimer und L. Pincussen. Band 1: Reine und physiologische Physik, physikalische Chemie und biologische Anwendungen. Pp. vi+522. (Berlin: W. Junk, 1925.) Subscriptionspreis für alle vier Bände (einzelne Bände werden nicht abgegeben) 100 marks.

THESE are, we believe, the first biological tables of their kind, and in one respect they indicate very clearly the degree to which the biological sciences have advanced quantitatively. The old barriers dividing the so-called exact and the descriptive sciences are down, and many are exploring long-neglected territory. Science has to wait for its problems to be tackled, but there are now biologists who can themselves go a long way in problems demanding some exact science. To these and to others following in their wake, we think that these tables will be of great service.

The authors are very frank in acknowledging the prototype of their work, and they assure us that what they have prepared is nothing but a Landolt-Börnstein of the entire field of biology; this includes physiology, anatomy, medicine, hygiene, zoology, botany, technics, pharmacology and bacteriology.

The range of information is extraordinarily wide, but there remains the all-important question of accessibility of the data. How easy is it to find the required information? The volume under review contains 522 pages, literally packed with data. The table of contents occupies one page and indicates thirty-four different sections. While, of course, some sections are longer than others, it will be seen that considerable time must be taken in getting what these tables have to give; vastly less time, however, than by any other method. Readers have the opportunity of consulting the original papers, for references to these are given at the ends of the sections. The authors have been at great pains to secure trustworthy data, and we have little doubt that advantage will be taken by scientific workers and readers of this mass of information.

Plant Life on East Anglian Heaths: being Observational and Experimental Studies of the Vegetation of Breckland. By Dr. E. Pickworth Farrow. Pp. x+108+23 plates. (Cambridge: At the University Press, 1925.) 7*s.* 6*d.* net.

THE interesting studies of vegetation at Breckland, East Anglia, which Dr. E. Pickworth Farrow has been publishing in the *Journal of Ecology*, have now been gathered together and published, with additional matter, in book form. This work provides the most definite and striking data as to the effects produced by rabbits in determining the nature of the vegetation. Thus their influence is traced in the degeneration of Calluna heath to grassland and in the prevention of natural regeneration of woodland. Interesting notes are provided on wind effects upon Calluna in sandy soils and upon the water supply in the soil as a determining factor in the type of vegetation of the soils at higher levels at Breckland, but in the main this work is characterised by the manner in which it underlines the significance of biotic factors. Cases that may be cited, in addition to the rabbits, are the effect of the shade thrown by Pteris, notably by the dead fronds, upon the spread of Calluna, and the influence of the litter of needles below the pines upon the spread of *Carex arenaria*.

Analytical Geometry of Conic Sections and Elementary Solid Figures. By Dr. A. Barrie Grieve. Pp. xv+314+xiv. (London: G. Bell and Sons, Ltd., 1925.) 9*s.* net.

A TEXT-BOOK for students who have already finished the straight line and circle: its contents are about equally divided between the conic sections and the geometry of three dimensions, finishing with confocal quadrics and a chapter on curvature. The author wisely uses the calculus for finding gradients, but also gives the alternative treatment. The book can be confidently recommended for boys reading for scholarships and for first-year students at universities.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor 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 Boskop Skull.

TWELVE years ago there was discovered in the Transvaal a remarkable human skull of apparently great antiquity. Fitzsimons, of Port Elizabeth Museum, first described it as perhaps allied to the Neanderthal but without the large supra-orbital ridges. The skull was next sent to Capetown on loan, where it was described at some length by Haughton as allied to the Cromagnon man. Shortly afterwards I examined it in Port Elizabeth, and, impressed by the huge size of the brain, the great thickness of the bone—in places 15 mm.—and certain remarkable features in the jaw, I thought it worthy of specific rank and named it *Homo capensis*. Now the specimen has been sent to the British Museum for further examination, and there has just appeared a paper by Pycraft which will be regarded as the official British Museum report.

Prejudice has played a considerable part in anthropology. Since the belief in evolution became accepted, all old human skulls are expected to be ape-like, and if not ape-like are regarded with suspicion. Doubts have been thrown on the Galley Hill skull because it is not sufficiently anthropoid. When in 1855 a human jaw was found in the Red Crag it was submitted to Owen, Huxley, Lyell, and all the leaders of the day, but as it was not like an ape's jaw they all shook their heads and said it was an interesting curiosity, and as no one recognised its value the jaw got lost. The Boskop skull has been threatened with a similar fate. It has an enormous brain and is not at all ape-like. Therefore, according to some, it cannot be old, and in any case cannot be very interesting.

Pycraft, in concluding that it is a Proto-Bushman type, agrees with the view I expressed some years ago, and in his phylogenetic tree he places it low down on the branch that leads to the Bushman and Negro. Unfortunately elsewhere in the paper he states "very certainly that he was a derivative of Cromagnon man," and Cromagnon man he places well up the branch that gives rise to the European types of to-day.

By means of certain formulæ Pycraft estimates the cranial capacity at 1717 c.c. Haughton estimated it at 1832 c.c., Elliot Smith puts it at 1900, and I made it 1950 c.c. Sollas has just shown that those beautiful formulæ, while fairly trustworthy for normal-sized skulls, are quite untrustworthy for large skulls, giving at times an error of more than 200 c.c. If instead of estimating the capacity by formulæ suitable for normal skulls of *Homo sapiens*, which do not take into consideration the abnormal thickness in places, and the unusual thinness in others of a skull like the Boskop, we make a cast of the brain in plaster and restore it into at least approximately its original condition and then measure its size, as I have done, I still feel quite confident the capacity will be found to be more than 1900 c.c.

In Pycraft's paper there is one serious omission which I deeply regret. He admits that there is preserved "a fragment of a mandible" and it is not at all an inconsiderable fragment. It was on this jaw largely that I (not Hewitt, as Pycraft states) founded the species *Homo capensis*, believing that the jaw differs in certain characters from all other known human types. I may be entirely wrong in my view of the jaw, but it was with considerable disappointment that I found Pycraft had a good deal to say on the easy problem of the cranium, and not a single word to say on the more interesting and much more difficult problem of the jaw, and until this mandible has been fully investigated by some expert we cannot accept as final any verdict pronounced on the cranium alone.

R. BROOM.

Douglas, South Africa,
November 10.

The Energy liberated by Radium.

WHEN radium is in equilibrium with its disintegration products, it is known that the number of atoms of each of the products disintegrating per second is the same, and that this is equal to the number of α- or β-particles emitted by each product per second, according as the transformation is accompanied by α- or β-ray emission respectively. Moreover, in the case of those products (RaB and RaC) which emit γ-rays, Kovarik (*Phys. Rev.*, 23, 559, 1924) has recently established the important result that each disintegrating atom emits only *one* γ-ray (quantum). The number of γ-quanta emitted per second by the amount of Ra(B + C) in equilibrium with 1 gm. of radium was found to be $7{\cdot}28 \times 10^{10}$, from which we may conclude that each product emits $3{\cdot}64 \times 10^{10}$ γ-quanta per second.

Much valuable information on the energy of the γ-rays emitted by radioactive substances has also been obtained by measuring the energy of the β-rays excited by γ-rays incident on various elements, and afterwards applying Einstein's photoelectric equation, but further work will be necessary before our knowledge of the energy of the γ-rays is complete. Recent experimental work by Ellis (*Phil. Mag.*, 50, 521, 1925) has shown that the contribution of the γ-rays from Ra(B + C) to the total heat production of radium together with its short-lived products amounts to about 6·3 per cent., a value which is about 1·6 per cent. higher than that hitherto accepted. Theoretical calculations of this heat production have also been carried out, on the basis of the photoelectric data on the energy of the γ-rays, referred to above. Thus Meitner (*Die Naturwissenschaften*, 12, 1146, 1924) finds that the γ-rays from Ra(B + C) contribute slightly less than 9 per cent. of the total heating effect of radium (*ca.* 137 cal./hour/1 gm. Ra), whereas Thibaud (*C.R.*, 180, 1166, 1925) calculates that they contribute slightly more than 5 per cent. of the total heat production. The deviations of these calculated values from that found experimentally by Ellis are probably due to the fact that the γ-radiation from these elements is not homogeneous, but consists of several wave-lengths, which means that we must know how much these individual frequencies contribute to the aggregate effect, and on this point there is not complete unanimity of opinion. Moreover, such calculations involve a knowledge of the number Z of atoms of radium disintegrating per second per 1 gm. of the element, and here again there is a divergence of opinion. Meitner uses the value $3{\cdot}5 \times 10^{10}$; Thibaud uses the value $3{\cdot}57 \times 10^{10}$ (Rutherford-Geiger); whilst Ellis (*l.c.*) recently used the value $3{\cdot}4 \times 10^{10}$ (Geiger-Werner, *Zeit. f. Phys.*, 21, 197, 1924).

Interesting information on the latter point can be obtained if we attempt to calculate the total heating effect due to 1 gm. of radium alone, *i.e.* free from its disintegration products. Here the conditions are simplified, for radium does not emit primary β-particles. Moreover, the γ-radiation emitted by radium is homogeneous (cf. Meitner, *l.c.*)—$\lambda = 6{\cdot}64 \times 10^{-10}$ cm.—and its energy can be calculated if we make what

seems to be a plausible assumption, namely, that the number of γ-quanta emitted per second by 1 gm. Ra has the value Z. The total heat production is obtained by adding this amount to that due to the α- and recoil particles. The results of this calculation are given below, (1) on the basis of Geiger's value of $Z = 3{\cdot}40 \times 10^{10}$, and (2) on the basis of the value of Hess-Lawson (*Wien. Ber.*, 127, 405, 1918; *Phil. Mag.*, 48, 200, 1924), namely, $Z = 3{\cdot}72 \times 10^{10} \pm 0{\cdot}02$.

The energy (E_α) of each α-particle emitted by radium has the value $7{\cdot}529 \times 10^{-6}$ erg, that of the recoil particle ($E_r = \frac{m_\alpha}{M_r} . E_\alpha = 0{\cdot}018 E_\alpha$) amounts to $0{\cdot}136 \times 10^{-6}$ erg, and each γ-quantum possesses an amount of energy of magnitude $0{\cdot}296 \times 10^{-6}$ erg. Thus the total energy liberated per atom disintegrating amounts to $7{\cdot}961 \times 10^{-6}$ erg. From this it is a simple matter to calculate the total heat development H of 1 gm. of radium in calories per hour. We obtain the following results:

(1) for $Z = 3{\cdot}40 \times 10^{10}$, $H = 23{\cdot}28$ cal./hour.
(2) for $Z = 3{\cdot}72 \times 10^{10}$, $H = 25{\cdot}47$ cal./hour.

Value of H obtained experimentally $= 25{\cdot}2$ cal./hour.

We see, then, that the deviation of the calculated from the experimental value of the heat production of radium amounts to about -8 per cent. or $+1$ per cent., according as we make use of $Z = 3{\cdot}40 \times 10^{10}$ or $3{\cdot}72 \times 10^{10}$ respectively.

Now a consideration of the value 25·2 cal./hour for the heat development of 1 gm. of radium, as obtained by Hess (*Wien. Ber.*, 121, 1419, 1912), indicates that it is more likely to be a shade below than above the true value. The determination was made with nearly $\frac{1}{2}$ gm. of radium, which had been specially purified by Hönigschmid for atomic weight determinations, and great care was taken to eliminate the effect of the decay products of radium from the result. On the other hand, the possible contribution of the γ-rays from radium to the heating effect was at that time generally regarded as negligible. Recent work, however, shows that it is not so. Absorption measurements with the γ-rays from radium yield three values of μ (in aluminium) for these rays, namely, 354, 16·3, and 0·27 cm^{-1}. The half-value thicknesses corresponding to these absorption coefficients are 0·002, 0·042, and 2·56 cm. of aluminium respectively. Now the thickness of absorbing material in Hess's determination of the heat production of radium was equivalent to 4·9 cm. of material of unit density, which corresponds to 1·8 cm. of aluminium.

It follows that the first two constituents of the γ-radiation referred to above would be completely absorbed, whereas less than half of the third and nuclear constituent would suffer absorption. An exact estimate of the fraction of the total γ-radiation which remained unabsorbed in the experimental determination is not readily obtainable, but it would almost certainly be *less than* half the total. In other words, since the total heat developed by the γ-radiation from 1 gm. of radium works out to be 0·947 cal./hour, the corrected hourly heat development due to all the rays emitted by 1 gm. Ra, as determined experimentally by Hess, cannot differ much from 25·5 cal., a value which is almost identical with that calculated under (2) above.

A comparison of the above results of theory and experiment thus lend strong support to the essential correctness of the value $Z = 3{\cdot}72 \times 10^{10}$ for the number of α-particles emitted by 1 gm. of radium per second, and it is significant that Kovarik's work on γ-rays is in substantial agreement with this result.

In the above calculations, I have endeavoured to use the most accurate data available for the various quantities involved, and it is important that the values used should be stated. They are as follows: (1) Wave-length of γ-rays from radium $= 6{\cdot}64 \times 10^{-10}$ cm. (Hahn-Meitner); (2) velocity of α-particles from radium $= 1{\cdot}511 \times 10^{9}$ cm./sec. (Geiger); (3) mass of α-particle $= 6{\cdot}595 \times 10^{-24}$ gm.; (4) velocity of light $= 3{\cdot}000 \times 10^{10}$ cm./sec.; (5) Planck's constant (h) $= 6{\cdot}55 \times 10^{-27}$ erg. sec.; (6) Joule's equivalent $= 4{\cdot}186 \times 10^{7}$ ergs/calorie.

ROBERT W. LAWSON.

University of Sheffield,
November 9.

Human Personality and Biochemistry.

A REVIEW of Prof. Louis T. More's "The Dogma of Evolution" (NATURE, October 17, 1925, p. 562) contains this sentence:

"The absurdity of some of the attempts to overcome this difficulty quoted by Prof. More, is almost incredible, as, for example, that of Prof. Ritter who maintains that every individual organism is a chemical compound!"

Here are the words in More's quotation from me to which this statement probably refers:

"An essential implication of this proposition is that every living individual organism has the value, chemically speaking, of an elementary chemical substance."

It seems from this that to the reviewer (signed E. W. M.) the words "has the value of an elementary chemical substance" mean the same as the words "is a chemical compound." To me the two phrases are very far from meaning the same thing. But were there no better reason than a desire to debate this point of difference between the reviewer and myself, I should not feel justified in asking NATURE for space in which to print even a brief communication in connexion with the criticism passed upon others and me by More and E. W. M. But I think there is a much better reason for requesting such a privilege.

According to this reviewer, the "incredible absurdity" committed by me resulted from the "difficulty of explaining how the typical proportions of this mixture [of compounds]" (*i.e.* of which protoplasm is now known to be composed) is maintained. Where he got the impression that I was trying to "explain" the phenomenon he mentions it is hard to see. For neither the word explain nor any synonym for it occurs in More's quotation from me, or anywhere in the original discussion.

As a matter of fact, my object in formulating the hypothesis quoted by More was very different from what E. W. M. says it was. This I think he could scarcely have failed to recognise had he read somewhat carefully all I wrote on the subject. But since More and E. W. M., and so presumably others who may have read my discussion, have missed by a long way what I was trying to bring out, I wish now to see if I cannot state the point in a nut-shell and so clearly as to ensure against it being misunderstood by anybody else who may chance to be interested in my results on the general subject dealt with.

What I tried to do originally was to bring into recognisably harmonious relation with each other two groups of facts concerning organisms, human organisms especially, which are questioned by nobody of good sense and sound learning, although scarcely anybody is able to see exactly how they can get on together in one and the same individual.

One of these factual groups is human personality; the other is the human organism's ability to continue to live by means of its food substances. How, for example, is it possible for a great Nordic statesman

and his humble negro valet to breathe the same kind of air, drink the same kind of water, and eat the same kinds of solid food year in and year out, and yet one of them go right on being a great Nordic while the other as persistently continue to be a humble negro? If there is any truth in Feuerbach's epigram, "Mann ist, was er isst," how can such a thing be?

What I wrote, essentially, in attempting to throw some light into this dark place, which has drawn the fire of these critics is this: Every elementary substance is different from every other as to its physical attributes and as to the products of its chemical reactions with other elementary substances. Likewise every human person is different to some extent from every other as to many of his physical attributes, and as to his chemical reactions with certain elementary substances, notably with atmospheric oxygen. That these two groups of facts constitute a rather striking resemblance between a chemically elementary substance and a human organism scarcely needs saying in so many words when they are presented in this bald way.

I further directed attention to the idea that the validity and perhaps the significance of this resemblance are increased by drawing consciousness into the comparison. Thus when the conscious organism is deprived of air (oxygen) its consciousness ceases as inevitably and almost as promptly as does the flame of a lump of phosphorus or sulphur under like deprivation. Furthermore, the utter differentiatedness of every person's conscious activity from every other person's, and the consequent possession by every person of a measure of genuine uniqueness, is comparable with the differentiation that characterises the chemical reaction of every elementary substance with every other such substance.

As to its conscious life especially, the definitiveness of every human person is like unto the definitiveness of a chemically elementary substance.

To show that the separate reality of each and every conscious person is comparable with the separate reality of each and every chemically elementary body is the essence of my discussion from which More quotes. What I did was to manipulate, by the methods of description and comparison, certain well-established facts concerning the nature of man and some other organisms, and other well-established facts concerning the nature of certain inanimate bodies, with the view of finding how much they have in common.

If this performance deserves to be stigmatised as "incredibly absurd" materialism, the stigma rests on the facts rather than on me.

The separate and more difficult question of whether such a way of treating the facts really connotes materialism cannot, of course, be gone into in a brief communication like this.

This much may, however, be said: My description of conscious human personality recognises its utter dependence on material substances and atoms, but it also recognises that the worth and dignity of each human person are real in the same sense that the atoms themselves are real. So far as I can learn, materialism has never recognised such a relation between a personality and the atoms of which it is composed.

WM. E. RITTER.

Science Service,
Washington, D.C.,
November 11.

PROF. RITTER'S further explanation of his meaning leaves me gasping! Apparently I did him an injustice in supposing that he meant to compare the human organism to a chemical compound. What he really intended was to compare each human individual to a chemical element. Just as each element reacts differently with oxygen and thereby manifests its individuality, so each human being reacts differently to oxygen, and in this his personal peculiarities find their explanation.

We might remark that chemical atoms (barring radioactive transformations) persist and are indestructible, whereas the human being in so far as he consists of matter is a temporary phenomenon. Further comment, however, on this extraordinary comparison appears to be superfluous.

E. W. M.

A Surface Catalysis in Photochemical Processes.

DURING the course of an investigation on the photochemical combination of gases, our attention was directed to the marked diversity in the rate of combination of gases such as hydrogen with oxygen, ethylene and carbon monoxide, effected by irradiation in quartz tubes with the mercury vapour lamp, observed by different investigators.

It is a well-established fact that pure hydrogen and oxygen can combine when subjected to radiation of short wave-length, but owing in general both to the weak absorption coefficient of the gases, probably oxygen being the important constituent, and the feeble nature of light at wave-length shorter than the resonance line $\lambda = 2537$ Å to which such photo-activity is due, the rate of combination is generally small. Indeed at low pressure Dickinson failed to note any combination. Again, if mercury vapour be admitted to the system, Franck and Cario have pointed out that the mercury atoms are activated to the $2p_2$ state by absorption of quanta of light of wave-length 2537 Å.U., and such activated mercury atoms on collision with hydrogen molecules produce an active modification of hydrogen which can react either with the gases mentioned above or with metallic oxides. It is uncertain at the present time whether this "active" modification so produced consists of activated hydrogen molecules, a point of view held by Mitchell, hydrogen atoms as suggested by Franck and Cario, or an unstable but active mercury hydride postulated by Compton.

When a comparison is made of the rates of these two homogeneous gas reactions obtained by observers such as Franck and Cario, Dickinson and Mitchell, with the relatively high rates obtained by Berthelot and Gaudechon, Baker, and especially Taylor, on illuminating a gas mixture *in the presence of liquid mercury*, it was evident that the discrepancy was too great to be accounted for by variations in the intensity of the line $\lambda = 2537$ Å.U. from the lamps of the different observers. Taylor indeed has recently realised this discrepancy and suggested that combination is in effect a chain mechanism of the type postulated by Christiansen and Kramers. Whilst some species of chain reaction does undoubtedly occur in a few cases, such as in the combination of hydrogen and chlorine, it appears improbable that the diversity of the results between the two groups of experimentalists can be attributed to some unknown factor causing the inhibition in the former, or the propagation of chains in the latter cases.

An investigation of the catalytic effect of a mercury surface in the photochemical combination of these various gas mixtures revealed the interesting fact that combination between these gases is promoted by a mercury surface when illuminated at ordinary temperatures with radiation from a quartz mercury vapour lamp under the conditions of strong emission of the resonance line $\lambda = 2537$ Å.U.

We have likewise made a search for any catalytic effect of metals such as iron, copper, cadmium, and silver, when radiated with the mercury and cadmium

vapour lamp and the iron arc, but apart from the already well-known small increase in the rate of oxidation of reduced iron and copper on illumination, no definite signs of catalytic effects were obtained, possibly on account of the relatively feeble intensity of the resonance lines for these metals in the arcs employed. In the case of mercury irradiated with the water-cooled mercury arc the catalytic effect is, however, most distinct. Thus in a series of experiments with *ca.* 30 c.c. of hydrogen and oxygen, in an approximate ratio of 2 : 1, at a total pressure of 300 mm., both in the absence and presence of mercury vapour the rate of combination was so slow that in a period of five hours a change in pressure of less than 1·0 mm. was obtained. In the presence, however, of a layer of mercury 10 cm. long, disposed in the horizontal reaction tube, a change in pressure of 60 mm. an hour was obtained. The rate of change is to a first order proportional to the area of mercury exposed. Amalgamated silver is likewise effective as a catalyst, but amalgamated brass possesses but little efficiency. In this latter case it may be observed that owing to the operation of the forces of surface tension, zinc and not mercury is the predominant constituent of the surface layer.

Whilst in the absence of hydrogen, ozone can be identified by the tailing of the mercury, when hydrogen is present mercuric oxide is formed on the mercury surface and is also deposited on the tube walls.

Auto-retardation of the rate of reaction is to be noted when formaldehyde and its polymerised products from carbon monoxide and hydrogen condense on the previously clean mercury surface. Although ethylene is sensitive to light in the absence of mercury, the combination of this gas with hydrogen proceeds smoothly at a greatly accelerated rate in the presence of the illuminated mercury surface.

The operation of this hitherto unsuspected catalytic action of a mercury surface in the photochemical combination of gases provides a reasonable explanation, so far as can be ascertained from the published information on the experimental methods adopted, for the high rates of combination frequently observed. It must, however, be admitted that the data of Coehn and Tramm do not conform to this view, for a remarkably rapid rate of combination was obtained for pure gases. It is possible that mercury was actually present, being drawn into the reaction vessel from the one ground-in joint with which their reaction system was provided, since their diagram lends support to the view that the joint was provided with a mercury seal.

We have not as yet obtained definite information as to the quantum efficiency of the surface, or whether water vapour is essential for this surface action; it appears, however, to be unnecessary for the operation of the Franck and Cario mechanism.

H. S. HIRST.
E. K. RIDEAL.

Laboratory of Physical Chemistry,
Cambridge,
November 20.

The Cierva Auto-gyro.

IN his article on the Cierva auto-gyro in NATURE of October 31, Prof. Bairstow repeats an argument originally used against the helicopter, that the longer spiral path of the blades, as compared with the straight path of aeroplane wings, causes a greater expenditure of energy for a voyage of a given length from point to point.

Munk arrives at the contrary conclusion in Technical Note No. 221 of the American Advisory Committee for Aeronautics. On pp. 10-11 he writes: "The average velocity of the helicopter blade is greater than that of the aeroplane wing and this involves greater loss. . . . However, the helicopter makes up again for this by its smaller wing area . . . ," and finally, "The loss due to the drag of the [helicopter] wing is accordingly smaller."

I find it difficult to simplify the basis of comparison sufficiently to draw any general conclusion, but am of the opinion that Prof. Bairstow's argument requires considerable modification on the lines laid down by Munk.

A. R. LOW.

London, November 28, 1925.

THE argument for relative efficiency of aeroplane *v.* auto-gyro as given in my article does not depend on the area of the wings used, and it would seem that Munk can only reach his conclusion by imposing on the aeroplane some disability not shared by the auto-gyro. The disability is made clear on p. 11 of the report referred to by Major Low, where we find "the aeroplane wing area is not chosen for the ordinary velocity of flight, but for the much smaller velocity used for taking off and landing, and in consequence is much greater than it would need be for ordinary flight alone." This paragraph means that at high speeds an aeroplane cannot use its wings at the best ratio of lift to drag, and this is a well-known phenomenon. The argument as to the advantages and disadvantages of the two types of craft becomes very technical if carried into this stage, and I cannot press my point further here than as one of opinion backed by the knowledge that experiments have not yet demonstrated the capabilities of the auto-gyro to overcome the disadvantage of the aeroplane to which attention has been drawn by Munk.

Put in terms of lift/drag the difference of statement seems to disappear; on p. 7 of N.A.C.A. Tech. Note No. 221 Munk says: "I proceed now to the energy balance of the tilted propeller. This will give information on the economy of the helicopter. It is enough to analyse the results of tests 136 to 141, which is done in Table VIII. The table shows that the ratio L/D of the propeller is considerably smaller than for ordinary wings. . . ."

L. BAIRSTOW.

The Free Path of Slow Protons in Helium.

POSITIVELY charged hydrogen atoms with velocities acquired by falling through 300 to 900 volts have been found to possess an unexpected range in helium and other gases. With helium pressures so high as 0·5 mm. of mercury, the protons will complete a semicircular path 16 cm. in length and still appear as a positively charged bundle of rays. The magnetic deflexion shows also that they remain charged throughout their entire path. As the free path given by the kinetic theory of gases for a rapidly moving particle is 1·5 millimetres at this pressure, the protons must pass unaltered through more than one hundred helium atoms. The capture of electrons by α-rays of various velocities observed by Henderson and Rutherford, and Rüchardt's experiments with canal rays, would lead one to expect a rapid neutralisation of protons of this velocity. The neutralisation of the more rapidly moving particles observed in those experiments has been explained by the presence of a great number of electrons, due to ionisation, with which the particles may combine, and we may account for the absence of neutralisation in the present experiments by the assumption that no free electrons are produced by protons of the velocity used. In fact, energy considerations would suggest the improbability of an

electron leaving a helium atom with an ionisation potential of 24·5 volts, in order to form a neutral hydrogen atom possessing a much smaller ionisation potential.

Singly charged helium atoms apparently do become neutralised, since they rapidly disappear as the pressure is increased. At 0·01 mm. pressure they are much weakened, and are entirely absent at a pressure of 0·027 mm. of mercury. Charged hydrogen *molecules* disappear at a higher pressure (0·07 mm.) than the charged helium atoms. They are probably dissociated without alteration of velocity or direction, at collisions with the helium atoms, since their disappearance, as the pressure is increased, is accompanied by the appearance of a group of protons with the slow velocity of the original molecules.

A. J. DEMPSTER.

University of Chicago,
November 9.

Winter Thunderstorms, 1925.

A LARGE number of reports were received in response to an appeal for observations of thunderstorms occurring in the British Isles during the first three months of this year. The following table shows the number of days on which thunder or lightning was reported:

1925.	England and Wales.	Scotland.	Ireland.	British Isles.
January . .	10	12	10	17
February . .	20	10	8	23
March . .	16	5	4	17
Total (3 months)	46	27	22	57

The stormiest areas in England were mainly on or near the south coast, and in Scotland they were in the central part of the west coast. Large areas in the northern and midland counties of England, and a large part of Wales, were free from storms.

The investigation will be continued during the first three months of 1926, and in thanking those who sent information last winter, may I ask for similar reports next year?

S. MORRIS BOWER.

Langley Terrace,
Oakes, Huddersfield,
December 1.

A Further Case of Sub-Harmonics.

THAT notes may be produced by the intermittent contact of a tuning-fork and another body, the frequencies being sub-multiples of that of the fork, has been shown in my earlier communications (NATURE, March 8, 1924; *Phil. Mag.*, January 1925). This letter is to point out that such sub-harmonic notes can also be obtained by rubbing with a wetted finger on or near the rim of an ordinary thin tumbler or of a wine-glass. The note most easily obtained corresponds to the fundamental "bell" mode of vibration in four segments, as may be seen by the ripples produced on a little water placed in the glass (one of the four nodal lines ends at or near the moving finger). By pressing harder and moving the finger more slowly, notes of a half, a third, and a quarter of the frequency of the above note can similarly be obtained. All these notes fall in pitch simultaneously when more water is placed in the glass. (Another note may occur, apparently due to the simple torsional vibration of the glass. This note is unaltered in pitch by varying the amount of water.)

W. N. BOND.

University College, Reading,
November 9.

The London Skull.

As Prof. Elliot Smith states in his letter to NATURE of December 5, a sample of the blue clay in which the skull was found at Lloyd's has been forwarded to me for examination at the instigation of Mr. Warren B. Dawson.

I am anxious to remove at once any possible misunderstanding regarding the results of my examination. It may have been thought that as I was familiar with the brick-earths in East Anglia, in which Mr. Reid Moir has found so much evidence of Mousterian culture, I might be able to establish some kind of correlation. As I pointed out at once, however, to Mr. Dawson, this was unlikely. The blue clay happens to be lithologically different from the Mousterian brick-earths of Suffolk, but even if it were similar petrographically, I should still regard its indigenous fauna as the only safe basis for correlation and determination of age.

My examination of the inorganic constituents of the clay may throw light on the conditions of deposition and the source of the material. I must leave the question of its age in the competent hands of Messrs. Bromehead and Hinton, who I hope will find it possible to arrive at an agreement.

P. G. H. BOSWELL.

Department of Geology,
University of Liverpool,
December 7.

Early Use of Lightning Conductor.

MR. H. C. BROWNE, in a letter on the early use of the lightning conductor (NATURE, Aug. 15, p. 242), quotes the "Tableau de Paris." Readers of NATURE may wish to refer to this interesting work. The "Tableau de Paris" was published between 1781 and 1788 in twelve volumes, by L. S. Mercier. The chapter quoted by Mr. Browne is of 1783. In the last volume of the collection is another chapter on the same subject, in which Mercier recants his former belief in the lightning conductor; he says: "In a city of 800,000 souls, I have not seen, in forty years, a single person killed by lightning."

Mercier's incredulity in scientific matters culminated, many years later, in a work the title of which speaks for itself: "De l'impossibilité du système astronomique de Copernic et de Newton" (Paris, 1806).

T. V. BENN.

Clermont-Ferrand,
October 31.

A Gift of Fleuss Vacuum Pumps.

WE have for disposal a few Fleuss vacuum pumps suitable for laboratory experimental work. The pumps can be either hand-worked or power-driven by a belt on the fly-wheel. They occupy a floor space of about 24 in. × 14 in. So far as the number available permits, we should be pleased to give one to any university laboratory or educational establishment in Great Britain where such a pump would be of value for experimental work.

The object of this letter is to make the fact known in the hope that any one desiring one of these pumps may see this letter and communicate with us direct.

C. C. PATERSON.

Research Laboratories of the General
Electric Company, Ltd.,
Wembley, December 8.

Atoms and X-Rays.[1]

By Dr. F. W. ASTON, F.R.S.

ISOTOPES AND IONISATION.

THE idea that all atoms of matter might be built of the same primordial units, that is to say, might differ not in material but only in construction, dates back at least as far as Prout. This philosopher endeavoured more than a century ago to show that atoms of all elements were themselves built of atoms of hydrogen. A little earlier Dalton had postulated, in probably the most important theory in the whole history of chemistry, that atoms of the same element were of equal weight. If both these theories were right, the atomic weights of all elements would be comparable with each other as whole numbers. This the chemists soon found was quite incompatible with experimental evidence. They had to choose between the two theories and chose the one that was untrue. In this they were perfectly right, for it is more important that a scientific theory should be simple than that it should be true.

The point cannot be tested by chemical methods, for these require a vast number of atoms, and so can only yield a mean result. The way in which Dalton's postulate was first attacked and shown to be incorrect was in the province of radioactivity, when Soddy showed that lead which was produced from thorium minerals had a different atomic weight from the lead which was produced from uranium minerals. This meant that substances could exist which had identical chemical properties but different atomic weights; these Soddy called isotopes. This reasoning could not be applied to ordinary elements. For these there is only one conclusive test, which is to compare the weights of individual atoms. It is here that positive rays are of such value, for they are atoms carrying a positive charge and moving with so high a speed that they can be detected by a fluorescent screen or photographic plate.

The first experimental comparison of the weights of individual atoms was made by Sir J. J. Thomson by his "parabola" method, in which the rays are subjected to electric and magnetic fields giving deflexions at right angles to each other. Subjected to this test, many of the elements seemed to obey Dalton's rule, giving single or apparently single parabolic streaks expected from groups of atoms travelling with different velocities but all of the same mass. But results obtained with neon suggested that in this gas the atoms were of two different weights 20 and 22, the accepted atomic weight being 20·20. The accuracy of the parabola method of analysis was not sufficient to prove the point, but this was done by means of the mass-spectrograph. With this instrument, by using electric and magnetic fields giving deflexions at 180° to each other, it is possible to focus the rays and obtain a spectrum dependent on mass alone. By measurements of this mass-spectrum it is possible to compare the weights of atoms to one part in 1000. In this way a satisfactory proof was obtained that neon did consist of two isotopes 20 and 22, which, present in the proportion 9 to 1, give the mean atomic weight 20·2. Chlorine, the chemical atomic weight of which is 35·46, was found to consist of two isotopes, 35 and 37. Many of the elements, such as carbon, oxygen, nitrogen, etc., were found to be "simple," that is, to consist of atoms all of the same weight, but even more were found to be "complex," mixtures of two or more isotopes. Selenium, krypton, cadmium and mercury each have six, tin probably eight, and xenon possibly nine isotopic constituents. In all, fifty-six out of the eighty known non-radioactive elements have been analysed into their constituent isotopes or shown to be simple with the results given in the table.

[1] From the presidential address delivered before the Röntgen Society on November 3.

TABLE OF ELEMENTS AND ISOTOPES.

Elements.	Atomic Number.	Atomic Weight.	Minimum Number of Isotopes.	Mass-numbers of Isotopes in Order of Intensity.
H	1	1·008	1	1
He	2	4·00	1	4
Li	3	6·94	2	7, 6
Be	4	9·02	1	9
B	5	10·82	2	11, 10
C	6	12·00	1	12
N	7	14·01	1	14
O	8	16·00	1	16
F	9	19·00	1	19
Ne	10	20·20	2	20, 22
Na	11	23·00	1	23
Mg	12	24·32	3	24, 25, 26
Al	13	26·96	1	27
Si	14	28·06	3	28, 29, 30
P	15	31·02	1	31
S	16	32·06	1	32
Cl	17	35·46	2	35, 37
A	18	39·88	2	40, 36
K	19	39·10	2	39, 41
Ca	20	40·07	2	40, 44
Sc	21	45·1	1	45
Ti	22	48·1	1	48
V	23	51·0	1	51
Cr	24	52·0	1	52
Mn	25	54·93	1	55
Fe	26	55·84	2	56, 54
Co	27	58·97	1	59
Ni	28	58·68	2	58, 60
Cu	29	63·57	2	63, 65
Zn	30	65·38	4	64, 66, 68, 70
Ga	31	69·72	2	69, 71
Ge	32	72·38	3	74, 72, 70
As	33	74·96	1	75
Se	34	79·2	6	80, 78, 76, 82, 77, 74
Br	35	79·92	2	79, 81
Kr	36	82·92	6	84, 86, 82, 83, 80, 78
Rb	37	85·44	2	85, 87
Sr	38	87·63	2	88, 86
Y	39	88·9	1	89
Zr	40	(91)	3·(4)	90, 94, 92, (96)
Ag	47	107·88	2	107, 109
Cd	48	112·41	6	114, 112, 110, 113, 111, 116
In	49	114·8	1	115
Sn	50	118·70	7·(8)	120, 118, 116, 124, 119, 117, 122, (121)
Sb	51	121·77	2	121, 123
Te	52	127·5	3	128, 130, 126
I	53	126·92	1	127
X	54	130·2	7 (9)	129, 132, 131, 134, 136, 128, 130, (126), (124)
Cs	55	132·81	1	133
Ba	56	137·37	(1)	138
La	57	138·91	1	139
Ce	58	140·25	2	140, 142
Pr	59	140·92	1	141
Nd	60	144·27	3 (4)	142, 144, 146, (145)
Hg	80	200·6	6	202, 200, 199, 198, 201, 204
Bi	83	209·00	1	209

By far the most important result of these measurements is that with the exception of hydrogen, the weights of the atoms of all the elements measured, and therefore almost certainly of all elements, are whole numbers to the accuracy of experiment, namely, about one part in a thousand. Of course, the error expressed in fractions of a unit increases with the weight measured,

but with the light elements the divergence from whole numbers is extremely small. This generalisation, which is called the *whole number rule*, has removed the only serious obstacle to the electrical theory of matter. It enables us to restate Prout's original hypothesis with the modification that the primordial atoms are of two kinds—protons and electrons, the atoms of positive and negative electricity. The proton is very much smaller and heavier than the electron, actually about 1850 times as heavy. According to the nucleus atom theory which we owe to Sir Ernest Rutherford, all the protons and about half the electrons are packed very close together to form a central positively charged nucleus, round which the remaining electrons circulate, somewhat like planets round a sun. All the spectroscopic and chemical properties of the atom depend on the positive charge on the nucleus, which is the excess of protons over electrons. This is clearly the number of planetary electrons in the neutral atom; it is called the *atomic number* and is actually the number of the element in the periodic classification—1 for H, 2 for He, 3 for Li, and so on. The whole-number weight of the atom, on the other hand, will be the total number of neutral pairs of protons and electrons it contains. This is also the number of protons in its nucleus, and is called the *mass-number* of the atom—1 for H, 4 for He, 6 and 7 for the isotopes of Li, and so on. Atoms are isotopic, that is, belong to the same element, when their nuclei have the same net positive charge, but they may have a different total number of protons, and so different weights.

We picture the atom as consisting of a central nucleus and an outer system of electrons, but when we come to inquire into the dimensions of the electrical particles themselves in relation to the dimensions of the atoms they compose, we are faced with a very surprising result. The protons and electrons are infinitesimal compared with the atom. To convey any direct idea of the numerical relations is almost hopeless, and were we to construct a scale model of the atom as big as the dome of St. Paul's, we should have some difficulty in seeing the electrons, which would be little larger than pin heads, while the protons in the nucleus would escape notice altogether as dust particles invisible to the naked eye. If we represent the nucleus of a helium atom as the size of a pea, its planetary electrons would be about a quarter of a mile away. Experimental evidence leaves us no escape from the conclusion that matter is empty. An atom, even of so heavy an element as lead, is as empty as the solar system and only occupies the spherical space we allot to it by virtue of the rapid and continuous rotation of its outer electrons. Led by the knowledge that under certain conditions these outer electrons could be stripped from the atom, and the nuclei thereby enabled to approach closer to each other, Eddington was able to predict that in certain stars matter could attain a density thousands of times greater than the greatest we know. This prediction has been strikingly verified by recent observations on the companion of Sirius, which at the same time have afforded another signal triumph for Einstein's relativity theory.

We have heard a good deal of loose talk in recent years of "splitting" the atom. Whenever you draw your fountain pen from your pocket you split countless millions of atoms in the sense that you violently tear planetary electrons away from them, by the friction between the ebonite and the cloth. This form of splitting is called ionisation. In it the atom suffers no sort of permanent injury. It simply captures the first electron it can to replace the one it has lost, and after notifying the world at large of its recovery by a wireless signal, it goes on exactly as before. In such a solid as copper, the exchange of electrons from one atom to another can be effected with the greatest freedom, and it is the passage of these loose electrons which constitutes the ordinary electric current. I suspect that the high conductivity of the negative glow, and of flames, is due to an exchange of a somewhat similar kind.

I mentioned the despatch of a wireless signal sent by the atom on repair of its injury. The type of this radiation depends on the extent of the damage done. For superficial effects it is light and radiant heat: for deeper and more violent effects it is X-rays. The displacement of the innermost and most tightly bound electrons gives rise to the hardest X-rays. The tightness of binding depends on the nuclear charge, so that for the emission and absorption of the hardest rays the heaviest elements must be employed. This property of the atom has already been dealt with by Sir Oliver Lodge in his address two years ago. It is to be emphasised that in all such cases we are only concerned with the outer electrons. With the nucleus it is a very different state of affairs. To dislodge any part of this requires violence of an altogether higher order, but if it is done the whole atom is changed, and changed permanently. This is no longer ionisation but transmutation.

Transmutation of the Elements.

Transmutation of the elements, so long sought by the alchemists, takes place spontaneously in the radioactive atoms, the nuclei of which are unstable and periodically eject helium nuclei and electrons, which are the well-known alpha and beta rays. Several claims of artificial transmutation of elements have been made recently in serious scientific journals. I will deal with the more doubtful ones first. Three years ago it was stated that helium was formed when a tungsten wire was deflagrated by an intense discharge. Sir Ernest Rutherford pointed out the extreme improbability of any disruption of the tungsten nucleus under these conditions, and a careful repetition of the experiments, with greater precautions, proved that he was right. Quite recently a claim has been made that helium has been produced by transmutation in a vacuum tube discharge. If true, this would be the greatest discovery in history, but the detection at the same time of neon, another atmospheric gas, is, to my mind, a very suspicious circumstance, and when these alchemists seriously suggest that success or failure may depend on the use of a particular form of obsolete make and break, my scepticism is increased.

A much more interesting case is that of the liberation of gold from mercury by electric discharge, even in an ordinary mercury vapour lamp. Here similar experimental results have been obtained by several investigators in different parts of the world, and the quantities of gold produced are remarkably large—large enough as we shall see to dissipate the hope, so confidently expressed, that it is formed by transmutation of the mercury atoms owing to the addition of an electron to

their nuclei. This claim was supported, I confess much to my surprise, by a well-known authority, on the ground that since the nucleus is positively charged, it would be quite easy to fire an electron into it. This is pushing the analogy of the sun and planet system to unjustifiable length. We know that a planet directed towards the sun would actually fall into it, but if every time an electron was directed towards a nucleus it fell into it and was absorbed, how could matter have a permanent existence at all?

We know there must be some mechanism in Nature which prevents such a collapse taking place in this simple manner. Even if we grant the theoretical possibility, there are still fatal practical objections. The addition of an electron to the nucleus of one of the isotopes of mercury will turn it into an atom of gold, but cannot alter its weight appreciably. Now the atomic weight of the so-called artificial gold has been determined by Hönigschmid, and agrees within experimental error with the value 197·2 assigned to ordinary gold. Quite recently, by means of a new and more powerful mass-spectrograph, I have been able to resolve the isotopes of mercury, and so determine its composition, which was previously in some doubt. I find that it consists of 198, 199, 200, 201, 202 and 204. There is no isotope 197 previously suspected. This fact, combined with the atomic weight, makes it quite certain that no transmutation of the kind claimed could produce the gold found. This is ordinary gold which must have been present in the mercury from the start. I understand that this view has now been shown to be right by the failure of the experiment when sufficient care is taken to eliminate all traces of gold from the mercury beforehand.

Unless our views on the structure of nuclei are very wide of the mark, failure in such experiments is inevitable, for the forces employed are ludicrously inadequate to cause disruption. The work of Rutherford, Chadwick, Ellis and others leaves no doubt that just as the dimensions of the nucleus are almost inconceivably small—the radius of that of aluminium is probably less than 4×10^{-13} cm.—so the forces binding together its component parts are gigantic and to be measured in millions of volts. Such forces are not yet available in the laboratory. They are, however, provided, on an atomic scale, in the form of the alpha particles shot out of radioactive atoms, and with these Rutherford has succeeded in producing real and definite transmutation. The method consists in bombarding the atoms with the swiftest alpha particles, which are helium nuclei with a velocity of more than 100,000 miles per sceond, which corresponds to an energy of many millions of volts. In order to effect a disintegration, these projectiles must make a direct hit on the nucleus. When this happens in the case of most elements lighter than potassium, a proton is dislodged from the nucleus, which is thereby transmuted into another element.

These observations have recently been strikingly confirmed by Blackett, who, using the beautiful Wilson fog-track method, has actually succeeded in photographing the disintegration of nitrogen nuclei struck by swift alpha particles. As I have already pointed out, the dimensions of the nucleus are minute compared with those of the atom. It can be calculated that an alpha particle colliding with an atom will only hit the nucleus once in about ten thousand million collisions, so that although each alpha particle makes about 200,000 collisions in completing its track, a very large number of photographs had to be taken. Actually some 400,000 tracks were photographed and eight disintegrations detected. In these the thin track of the dislodged proton could be clearly seen, and a somewhat unexpected feature brought out is that in each case the projectile is retained by the target. The nitrogen nucleus loses one proton but captures the helium nucleus fired at it, and so would appear to become an isotope of oxygen of atomic weight 17. No such body is known in Nature, which suggests that the atom so formed is not permanently stable.

Atomic Energy.

In the possibility of artificial transmutation lies the hope of one day releasing the so-called "atomic" energy. The whole-number rule is not mathematically exact, and it has been shown by direct measurements on the mass-spectrograph that an atom of helium, which consists of four protons, two nuclear electrons and two planetary electrons, weighs nearly 1 per cent. less than four atoms of hydrogen, each of which consists of one proton and one electron. The number of particles is identical, and the change of mass is ascribed to the different way they are arranged, and is called the packing effect. The theory of relativity tells us that mass and energy are interchangeable, and that if a mass m is destroyed, a quantity of energy equal to mc^2 is produced, where c is the velocity of light. Hence, if we could transmute hydrogen into helium, we should produce energy in quantities which, for any sensible amount of matter, are prodigious beyond the dreams of scientific fiction. For one gram atom of hydrogen, that is the quantity in 9 c.c. of water, the energy is

$$0{\cdot}0077 \times 9 \times 10^{20} = 6{\cdot}93 \times 10^{18} \text{ ergs.}$$

Expressed in terms of heat, this is $1{\cdot}66 \times 10^{11}$ calories, or in terms of work 200,000 kilowatt hours. In a tumbler of water lies enough power to drive the *Mauretania* across the Atlantic and back at full speed.

Here we have at last a supply sufficient even for the demands of astronomers; indeed, there is now little doubt that the vast supply of energy radiated by the stars can be kept up for centuries by the loss of an insignificant fraction of their mass. Whether this process is a degradation of hydrogen into helium, or the complete annihilation of matter by coalescence of its protons and electrons, is at present unknown. How long it will be before man is able to effect transmutation of matter into energy, and to what uses he will put such vast potentialities, are interesting subjects for debate. If scientific knowledge maintains its present rate of progress, the balance of probability is in favour of ultimate success, but this appears so far off that almost any speculation may be permitted. It may be that the operation once started is uncontrollable, and that the new stars which flare out from time to time in the heavens are but an intimation broadcast to the universe, of the first successful large-scale experiment on a far-distant world. It may be that the highest form of life on our planet will one day discover supreme material power, or cataclysmic annihilation, in the same ocean wherein, we are told, its lowest forms originally evolved.

Physics in Agriculture.[1]

By Dr. BERNARD A. KEEN.

THE study of the physical properties of soil has a fundamental place in the application of science to agriculture. It occupied an important position in the early days of agricultural science, and, after a lengthy eclipse in the latter half of the nineteenth century, when Liebig, Lawes and Gilbert, and others were establishing the modern agricultural chemistry and biology, it again came into prominence, owing to the recognition of the colloidal properties of the soil. The older concepts have been examined from this point of view, and it appears that the soil must be regarded not as a mass of comparatively inert grains over which water is distributed in a thin film, but as particles the surface of which is coated with colloidal material. The composition of this material is complex. It is a mixture of organic and inorganic substances derived from the decomposition of organic matter, and the weathering of clay, respectively, and it modifies very largely the deductions on the relations between soil and its moisture content made from the older hypothesis.

A soil can be easily divided into a few groups or fractions of different average size, depending on the velocity of fall in water. This process is known as mechanical analysis. It is a routine procedure in a soil survey and, combined with ecological and meteorological observations over the area, enables the expert to suggest improvements in the agriculture. In the case of undeveloped countries, this examination is essential if the agriculture is to be built up on sound lines. A striking example of the value of such a survey is afforded by the recent classification of Africa into areas according to agricultural potentialities, made by two American workers. The information was limited and the divisions are only approximate, but the very fact that it was possible to make them at all on such restricted information, shows the power and flexibility of the method.

In research investigations, the simple procedure of mechanical analysis must be replaced by more exact methods, in which the distribution of particles is expressed as a continuous function of the effective radius. One method depends on measuring the gradually increasing weight of particles settling on a pan immersed in a suspension of the soil in water, and from these data the distribution curve can be derived mathematically. The method is not yet perfect, because the settling particles that would eventually reach the liquid under the pan are naturally caught by the pan, whereas those in the annular space fall freely. In consequence, a density difference is established which sets up currents in the liquid, and the particles are deflected from their proper course.

For the purpose of this work, and for other studies, the Soil Physics Department at Rothamsted has developed an automatic and continuous recording analytical balance, illustrated in Fig. 1. A magnet is suspended from one arm, and the current through the solenoid is adjusted to keep the balance in equilibrium. The adjustment is automatic and is effected by using the motion of the balance beam away from equilibrium to complete subsidiary circuits which operate electromagnets controlling clockwork mechanism, that moves a sliding contact backwards or forwards along a slide wire. The current through the solenoid is, therefore, changed by the requisite amount. When the contact reaches the end of the slide wire, a third circuit is completed, and a phosphor bronze ball of known weight is automatically added to the magnet arm. The sliding contact rapidly returns to its zero position and the cycle of operations recommences. The resistances are so arranged that the relation between weight and length of slide wire across which the solenoid is connected is practically linear. Hence a pan attached to the sliding contact and resting on a rotating drum, gives a continuous record from which the change in weight can be inferred.

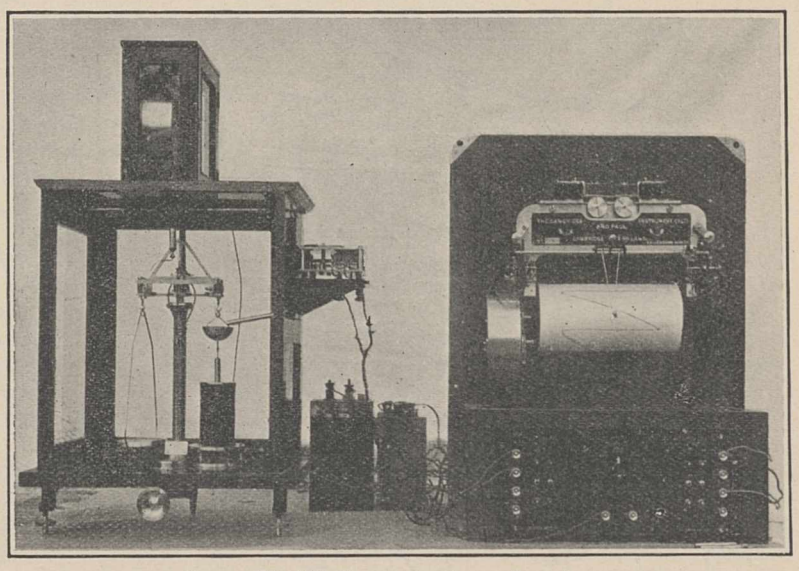

FIG. 1.—The Odén-Keen automatic recording balance.

The treatment of the flow of water through soil, in an analogous manner to the flow of heat or electricity through conductors, presents considerable difficulties, because the quantities corresponding to conductivity and potential (which for heat and electricity are practically independent of external conditions and current density) are not independent of the moisture content, the state of packing and the colloidal content of the soil. Although the difficulties of theoretical and practical investigation are great, much attention has

[1] Based upon a lecture on "The Physicist in Agriculture, with Special Reference to Soil Problems," being the ninth of the public lectures on physics in industry, arranged by the Institute of Physics, and delivered on November 25.

been devoted to the problem because of the practical applications, especially in areas under irrigation, where it is essential to make the best use of the available water, and yet to avoid the concentration of deleterious "alkali" on the soil surface resulting from an excessive upward movement of soil moisture. In regions with adequate rainfall, recent experiments at Rothamsted indicate that the depth from which water can ascend by capillary action, and thus become available for plant growth, is not very great. This emphasises the value of those cultivation operations designed to conserve the moisture in the upper regions of the soil.

The importance of the soil water relationships resulted in many additions to the original broad divisions of soil moisture into gravitational, capillary, and hygroscopic moisture. They were based on the assumption that the soil grains could be regarded as inert, but the recognition of the colloidal properties of soil has destroyed the validity and physical significance of these additions. Further, it has been shown that the vapour pressure of moist soil reaches its saturation value at a moisture content well below the values obtained for the so-called "equilibrium points" of soil moisture. This suggests that the moisture relationships are best expressed by other properties of moist soil, such as cohesion and plasticity, because variations in these factors are to be expected at moisture contents above the value for saturation vapour pressure. These properties have the further advantage that they are closely related to the behaviour of the soil under the action of cultivation implements, and they can be readily interpreted on the assumption that the colloidal material in soil forms a coating over the larger inert grains. Thus, the shrinkage of a plastic mass of kaolin, which normally follows a different course from that of soil, can be made closely to simulate the latter if a small amount of silica gel is previously precipitated on the surface of the kaolin particles.

In the field, the integrated effect of plasticity, cohesion, and surface friction between soil and a metal surface may be measured by a dynamometer in the hitch between the implement and the horse, or tractor. The drawbar pull thus recorded is found to vary considerably even on areas that to visual inspection are quite uniform. In a comprehensive field test, variations of more than 30 per cent. were found, even when the average drawbar pull of plots 66 ft. × 33 ft. was considered. For individual furrows the differences were much greater. The results are well illustrated by Fig. 2, where the "contours" of equal drawbar pull have been mapped from the results on a scale plan of the field. This variation is of obvious importance in competitive or comparative implement trials, for which, as an essential preliminary, a dynamometer survey should be made of the selected area. Other experiments show that the variations from point to point persist unchanged from season to season, and are not sensibly affected by manuring, with the exception of organic

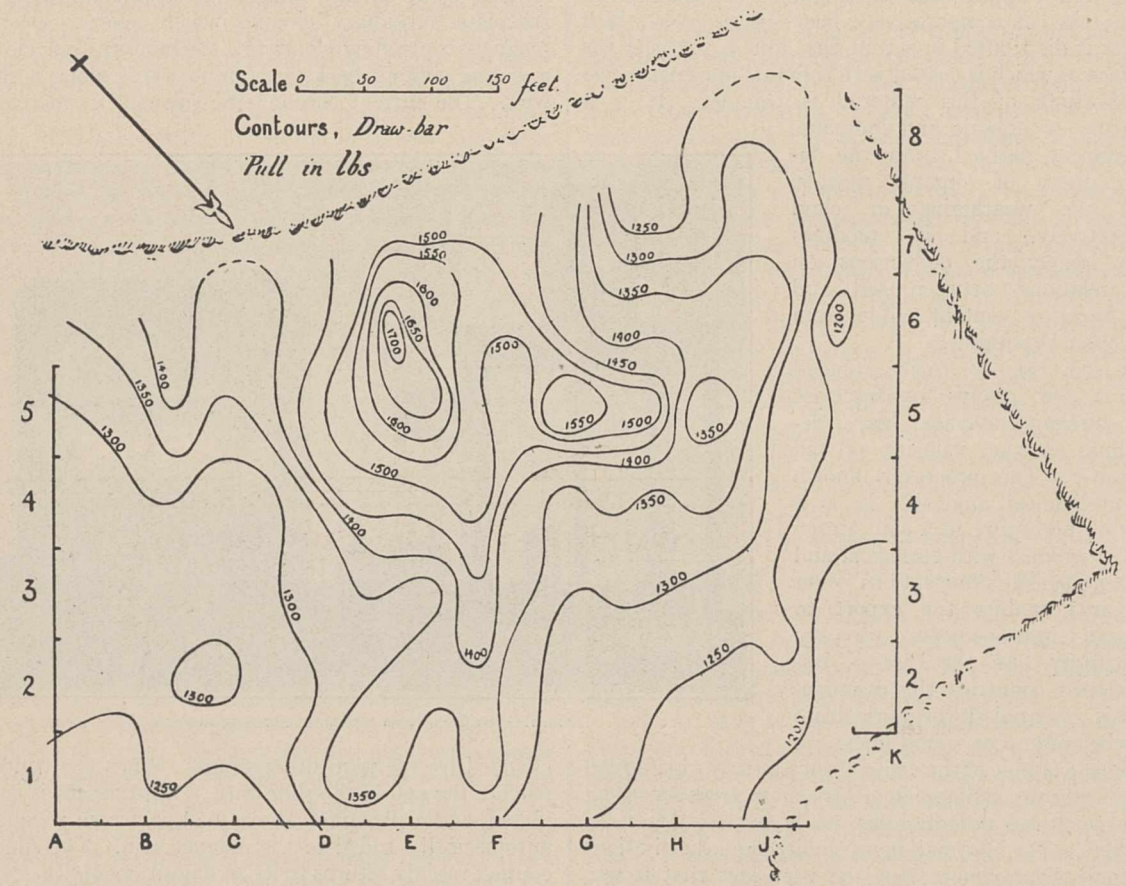

FIG. 2.—Lines of equal draw-bar pull over a supposedly uniform field.

manures. The variations in drawbar pull figures are also closely related to the amount of drainage and to the early stages of plant growth.

It is found that the drawbar pull is comparatively unaffected by speed of cultivation. Thus for tractor ploughing, an increase from $2\frac{1}{2}$ to 4 miles per hour, which would mean a 60 per cent. greater area ploughed in a given time, only involves a 7 per cent. increase in drawbar pull. It is improbable that the cost of the extra fuel necessary to give this increased pull would be more than a small fraction of the saving in labour costs due to increased speed of work. The design of tractors run at higher speeds without undue wear and tear, and of implements to perform satisfactory work at high speeds, should present no insuperable difficulties.

The Geology of the New Mersey Tunnel.

By Prof. P. G. H. BOSWELL, University of Liverpool.

ON December 16 H.R.H. Princess Mary inaugurated the work of excavation for the new tunnel under the River Mersey, sanctioned by Parliament last August. As is well known, a railway tunnel of invert form and 26 ft. in width has long been in existence; it was begun in 1881 by the Mersey Railway Company and completed some years later. The new tunnel is to be a highway and will be the largest of its kind. The major part of the tube will be circular in section, with an internal diameter of 44 ft., the road-way being constructed so as to take fullest advantage of the width. It will thus provide a four-way road for slow and fast two-way traffic, with side-walks of about 4 ft. for purposes of traffic control, etc. The cost of the tunnel is to be 4,750,000*l*., half of which will be provided by the Ministry of Transport in view of its highway character.

The line of the tunnel is to be roughly parallel to and about 150 yards north of the existing tunnel, its direction being about N.E.-S.W. The total length of tunnel will be rather more than two miles, of which about three-quarters of a mile will lie beneath the river.

At the Birkenhead end the entrance is to be near the Birkenhead Woodside Railway Terminus, and thus close to the docks. A suitable gradient of 1 in 30 will be obtained by a spiral descent. On the Liverpool side the tunnel will bifurcate, the northern branch ascending by a spiral gradient of 1 in 30 to the docks north of the pier-head, and the southern branch by a fairly straight stretch, of gradient 1 in 20, to an entrance in the heart of the city.

Throughout its course the tunnel will lie in Triassic sandstone and the overlying glacial deposits. On the Birkenhead side, under the River Mersey and for about 550 yards from the dock-walls on the Liverpool side, the rock belongs to the Middle Bunter Sandstone (or "Pebble-beds," though pebbles are scarce in the district). The beds dip at a low angle eastwards. The last 330 yards of the southern branch on the Liverpool side may be expected to lie in the Upper (Soft) Mottled Sandstone of the Bunter, which is here thrown down by a fault against the Middle Sandstone.

The latter is a firm, well-bedded rock, excellent for purposes of excavation, for it will stand well; the Upper Sandstone is rather soft. Both rocks, however, are renowned for the copious water-supply yielded by them.

It will be remembered that the Mersey estuary narrows considerably where Birkenhead and Liverpool are situated. Indeed, a rock-bar is responsible for the consequent ease of communication between those ports. Higher up the river, the overburden of glacial drift thickens, and, as the late T. Mellard Reade demonstrated, a deep channel of drift occurs at Widnes. As a result of his study of minor channels of drift in the area of the Liverpool and Birkenhead docks, Mellard Reade declared, before the Mersey railway tunnel was cut, his belief that they drained into the main buried channel, which would thus extend down the Mersey estuary, through the rock-barrier to the sea. He claimed, with good reason as the sequel showed, that geologists could previse, and warned the engineers that the channel of drift must be expected in the course of their operations. The channel was struck on the down-grade portion of the tunnel about 90 yards from the Liverpool side, and 44 ft. below the present bed of the Mersey, its base being closely 95 ft. below O.D. An unavailing attempt was made to avoid it, but fortunately the lowest 6 ft. of the channel (which was cut into for a length of about 66 yards) proved to be a stiff purple Boulder Clay. This clay yielded an excellent roof, and, unlike the sandstone, gave no trouble from water.

Another prediction, even more puzzling to those to whom the geology was not familiar, was that of the late G. H. Morton of Liverpool, who drew a geological section across the Mersey estuary and inferred the presence of a north-south fault with a westerly down-throw, under the bed of the river. This fault was struck in due course near the place assigned to it by Morton.

Trial-borings in the roof of the railway tunnel under the middle of the river proved a thickness of at least 15 ft. of Bunter Sandstone. The level of the top of the new tunnel in the part beneath the river will be nearly the same as that of the existing tunnel (approximately 106 ft. below O.D.). With the information made available by Mellard Reade and Morton, and the precision given to it by the excavations for the railway tunnel, and with the knowledge which has accumulated since (the officers of H.M. Geological Survey having re-surveyed the area just before the War), the engineers of the new enterprise will be fully forewarned of possible difficulties. But nobody, least of all a geologist, would care to predict the exact course, changes in depth, or lithological variation from clay to sand or gravel in a buried channel of glacial drift. There is no reason to doubt, however, that the new undertaking will prove successful.

Obituary.

PROF. A. FRIEDMANN.

IT has been briefly announced that Prof. Alexander Friedmann, director of the Central Geophysical Observatory, Leningrad, died of typhus fever on September 16, 1925, at the early age of thirty-seven years.

It is remarkable that under the auspices of the Academy of Sciences of Leningrad, which has recently celebrated its two-hundredth anniversary, the keen interest of Russia in scientific activities has been maintained throughout the stress and strain of war and revolution. The chief centres of geophysical activity before the War were the Central Physical Observatory at Leningrad and the Aeronautical and Magnetic Observatory at Pavlovsk (now Slutzk). The latter found itself between two armies after the revolution; but, with considerable difficulty, the work was maintained. From these centres the vast meteorological organisation of the Russian Empire had been controlled. It was naturally hampered a good deal by war conditions, but is being rapidly reinaugurated. After the death of Prince Boris Galizin, provisional arrangements were made for the scientific direction of the organisation; Prof. Obolensky was director for some time, and up to February of this year Prof. Weinberg was in charge.

At the congress on Applied Mechanics at Delft in April 1924 Russian representatives were present, and the number of papers which were offered overflowed the meeting-room and were made available in manuscript in the reading-room of the congress. Many of the papers were presented by Prof. Friedmann. He had graduated in 1910 at St. Petersburg, studied aerodynamics under Prof. Bjerknes in Leipzig, joined the Observatory at Pavlovsk, volunteered for the War as observer in the flying corps, was promoted to take charge of the aerological service of the army, and in 1918 became professor in the University of Perm. But in 1920 he returned to Leningrad as senior physicist at the Central Observatory, re-named Geophysical, of which he became director early in 1925. "A man of extraordinary mathematical capacity, he deliberately forced himself to experimental work in order to verify his results. He was entirely devoted to science; he worked hard himself and claimed hard work from his colleagues." In 1924 he started at the Observatory a new periodical, *The Journal of Geophysics and Meteorology*, wherein geophysical papers are printed in Russian with a brief summary in one or other of the foreign languages. His principal contributions to science are on "The Vortical Motions of the Atmosphere" in a periodical which he started as professor at Perm; "On Vortices in Liquids with variable Temperature," which he presented to the Mathematical Society of Kharkov; "On Differential Equations for Turbulent Motion of a Compressible Fluid," at the Congress of Applied Mechanics at Delft. He also contributed to modern mathematical physics papers on the curvature of space.

During Friedmann's short tenure of the directorship of the Central Geophysical Observatory he reanimated the organisation in an extraordinary manner. He was to have come to London for the meeting of the Upper Air Commission in April last; but at the last moment found himself unable to leave Leningrad. His activity was, however, effectively represented by Dr. Moltchanoff, the director of the Aerological Observatory at Slutzk. Almost every phase of the subject was covered by one or other of the series of papers presented in Friedmann's name or in those of his colleagues. Since that meeting many letters have been received from him about the establishment of geophysical observations in various parts of Russia; the last of them, dated July 25, announced the creation of a geophysical observatory at Jakutsk as a local branch of the Central Geophysical Observatory, meteorological and aerological at first, with the intention of its becoming astronomical, optical, and magnetic in time.

Friedmann's untimely death is a serious loss for Russian geophysical science; but regard for his memory will certainly impel his successors to carry on the work which excited his unbounded enthusiasm.

NAPIER SHAW.

MR. W. R. DYKES.

WE regret to record the untimely death of Mr. William Rickatson Dykes, secretary of the Royal Horticultural Society, at the early age of forty-eight years. Motoring with his wife near Woking, his car skidded, collided with a lorry, and he was thrown out, sustaining severe injuries to his ear and right arm. Attempts to save the latter failed, and he died of syncope, following the amputation of his arm at the shoulder, on Tuesday, December 1.

Mr. Dykes was born on November 4, 1877, the second son of Mr. Alfred Dykes, and educated at the City of London School, at Wadham College, Oxford, where he took classical honours, and the Sorbonne. He became an assistant master at Charterhouse in 1903, and remained there until the end of 1919, when he was elected to succeed the late Rev. W. Wilks as secretary of the Royal Horticultural Society. Under his secretaryship the Society has continued the growth started in 1888, and Mr. Dykes had recently taken a considerable part in furthering the plans (which are now well forward) for the building of a new and larger hall for the Society's meetings. His name, however, will be remembered, not so much for his work as a teacher, or as secretary of the Royal Horticultural Society, but chiefly for his devotion to the genus Iris.

Mr. Dykes had remarkable powers of concentration, an inquiring mind, a love of attempting to overcome difficulties in the cultivation of his plants, and facility in expressing himself in writing; and all of these he brought to the service of his favourite plant. While at Charterhouse he collected and grew all the species of Iris he could procure, and studied them minutely from both the cultural and the botanical sides. The mantle of Sir Michael Foster fell upon him, and one might almost say that Dykes had a double measure of the spirit that imbued that great iris lover. He was not content to follow authority, and took the utmost pains to investigate every small point that cropped up. He had correspondents wherever irises grew wild, and made himself acquainted with more than one foreign language in order to put himself in direct touch with first-hand information gathered by those

familiar with the plants in their native homes. He went to their native homes himself so far as he could in his vacations, and he made a fuller use of the garden in investigating relationships between diverse forms than probably any one before him, not only in this genus, but also in any other. His enthusiasm for the genus infected many another, and his many writings in gardening papers helped to spread the knowledge he had gained far and wide. In 1913 he published his great monograph on the genus, and it at once took its place among the best monographs upon a single genus which had appeared anywhere in the world; and in addition to this he wrote two other smaller books on the Iris family, which have gained wide appreciation. More recently, two other genera have competed in his affections with the Iris, and in the garden at Sutton Green, which he had recently acquired, he had collected very many species of tulip and of crocus, and he intended to study the tulip as he had the iris.

His last book was a translation of "La Taille Lorette," which will help to make Lorette's methods of pruning more familiar to English readers.

Dykes showed how invaluable an aid the garden may be in elucidating problems in relationship. He enriched the genus he made his own by raising many fine varieties, and he was doing the same with tulips.

The Veitch memorial medal and the Victoria medal in horticulture were both conferred upon him, largely on account of his work upon irises, the latter only a few days before his death.

We tender to his wife, whose interest and skilful pencil so greatly helped him, our deepest sympathy.

Sir Athelstane Baines.

We regret to record the death of Sir Jervoise Athelstane Baines, C.S.I., the distinguished authority on Indian ethnography, which took place at Kidlington, Oxford, on November 26. Sir Athelstane Baines was in his seventy-ninth year, having been born on October 17, 1847. He was the son of the Rev. Edward Baines, and was educated at Rugby and Trinity College, Cambridge. He joined the Indian Civil Service in the Bombay Presidency in 1870, when the first attempt to enumerate the Indian population, which extended from 1867 to 1872, was in progress. In the one-day enumeration of 1881, Baines was deputy superintendent of the census in the Bombay Presidency. The value of his work in this capacity led to his appointment as superintendent for the whole country in the next decennial census of 1891. The task of organisation occupied him for three years. This and his general survey of the results summarising the various State and Provincial reports, which was at once widely recognised as the work of a brilliant ethnographer and statistician, laid the foundations for much of the work of his able successors, Sir Herbert Risley, Sir Edward Gait, and Mr. Marten. Indeed to his inspiration, directly or indirectly, can be traced much of the admirable ethnographical work which has been done by members of the Civil Service. As a result of his census work, Baines was appointed to prepare the Decennial Report on Moral and Material Progress to 1891, and in 1894–5 to be secretary of Lord Brassey's Opium Commission. He was awarded the C.S.I. and retired in 1895.

On settling in England, Baines continued his ethnographical work, which included studies from various aspects of the three decennial Indian enumerations which have followed his retirement. He was a valued contributor to the proceedings of the Royal Statistical Society, of which he was president in 1909–1910. He also took part in public administration, being elected an alderman of the County of London and a member of the Oxfordshire County Council for 1917–1922. He was knighted in 1905.

Dr. Harold W. Nichols.

Dr. Harold William Nichols, a radio research engineer of Bell Telephone Laboratories, died on November 14 at his home in Maplewood, New Jersey. Dr. Nichols was born in Iowa on February 23, 1886. He received his education at Armour Institute of Technology, Chicago, and at the University of Chicago. In July 1914, he joined Bell Telephone Laboratories in New York City. He rapidly achieved distinction in the radio research activities of that organisation, and during the War, he was in charge of its radio work. During recent years he has been identified prominently with the investigations of ship-to-shore radio telephone service and of short waves in radio communication. He was recognised as an authority on "fading"; his papers on this phase of radio are distinct contributions to the art. He took a leading part in the transatlantic radio telephone tests in 1923, and for a lecture on this subject received the Fahie Premium from the Institution of Electrical Engineers. He had twenty inventions pertaining to the radio art to his credit and nine applications are now pending.

Dr. Nichols was a member of the American Institute of Electrical Engineers; the American Mathematical Society; the American Physical Society; the Institute of Radio Engineers; and the Sigma Xi and Eta Kappa Nu fraternities. His associates in the Bell Telephone Laboratories regard his death as a distinct loss to the profession as well as a great personal loss to themselves. He was a man of pleasing personality; an efficient and untiring worker, noted for his judgment and insight into all phases of the art of radio.

We regret to announce the following deaths:

Dr. Johan August Brinell, Bessemer medallist in 1907 of the Iron and Steel Institute, whose name is associated with the hardness testing of materials, on November 17, aged seventy-six years.

Prof. Joseph Brough, formerly professor of mental and moral science at the University College of Wales, Aberystwyth, and the author of "The Study of Mental Science," on December 7, aged seventy-three years.

Dr. Edmund Knecht, associate professor of technological chemistry in the University of Manchester, editor of the *Journal of Dyers and Colourists* and author of numerous works on bleaching, dyeing and other aspects of textile manufacture, on December 8, aged sixty-four years.

Current Topics and Events.

THE National Academy of Sciences and the National Research Council of the United States announce the forthcoming publication of the International Critical Tables. The first volume is to appear early in 1926 and is to be followed by four other volumes, comprising altogether about 2500 pages. The tables have been edited by Dr. Washburn, with Drs. Dorsey, West, Bichowsky, and Klemenc as assistant editors, who have had the co-operation of some three hundred experts in different parts of the world, but mainly drawn from the United States. According to the instructions to these experts, the tables are to differ in an important respect from many of the existing tables of physical and chemical constants. Instead of recording all or most of the determinations of a given constant which have been made, the co-operating experts were requested to give the most probable value of the constant after a critical consideration of all the determinations available. If this has been generally done with good judgment, the tables will be of great value to science. In a leaflet issued by the editors, the contents of the first volume, and the projected contents of the remaining volumes, are given. It is evident that very special attention is given to the needs of the technologist. The arrangement of the first volume is curious: an article on crystal structure is followed by articles on "dispersoidology, sweeting agents, odoriferous materials," and then by one on radioactivity. The published price of the set of five volumes is 60 dollars, but up to the appearance of the first volume early in 1926, members of scientific and technical societies, government departments, educational institutions, public libraries, etc., can subscribe at 35 dollars. The editorial expense of the tables, about 170,000 dollars, has been contributed by American industrial firms and benevolent foundations.

CORNELL UNIVERSITY, New York, has received an anonymous gift of 250,000 dollars, the income of which is to be used for the benefit and advancement of teaching and research in chemistry and allied fields. The gift is to enable the University to carry out a plan formulated by Prof. L. M. Dennis, Head of the Department of Chemistry, whereby prominent men of science will be invited to Cornell, each for one or two semesters, to present recent advances, and the methods and results of their own investigations. A private research laboratory will be placed at the disposal of the non-resident lecturer, who will thus be enabled to instruct a limited number of properly qualified students in his special field. The lecturers will be chosen so that different branches of chemistry or of allied sciences will be presented from term to term. The first incumbent of the lectureship in chemistry will be Prof. Ernst Cohen, professor of physical and inorganic chemistry in the van 't Hoff Laboratory at the University of Utrecht, Holland, who will be at Cornell during the second semester from February 1 until June 1, 1926. Prof. Cohen is the author of many books and pamphlets, comprising lectures and texts in the fields of inorganic and physical chemistry, and biographical studies of various distinguished chemists, including his famous predecessor, J. H. van 't Hoff. The original investigations of Prof. Cohen and his co-workers cover a wide range of topics in thermodynamics, thermochemistry, electrochemistry and piezochemistry. Prof. Cohen's researches upon metastable and allotropic forms of the elements have attracted particularly wide attention.

PROF. S. PARKER SMITH, of Glasgow, read an interesting paper to the Institution of Electrical Engineers on December 3 on an "all-electric house." The house he described was the ten-roomed house in which he lives. The total annual cost for heating and cooking, hot water, lighting and power last year amounted to only 43*l.* 8*s.* although neither coal nor gas was used. Seeing that about 16,600 electric units were used the average cost per unit works out to about $\frac{5}{8}$ths of a penny. In Glasgow arrangements can be made for heating water continuously between the hours of 11 P.M. and 8 A.M. at a price of $\frac{3}{8}$ths of a penny per unit. In order to get good thermal storage it is necessary to design a well-lagged tank. Cork lining was found well suited for this purpose, the fall in temperature during the daytime being less than 1° F. per hour. The hot-water tank installed had a cubical capacity of 87 gallons, the average consumption per person for all purposes being about 15 gallons per day. The tank is fitted with a thermometer marked "high," "medium," and "low" to indicate in which position the switch has to be placed in the evening. In summer it is sometimes only necessary to switch it on to the "low" position. This method of heating water economically is well known in districts which have a hydro-electric supply, and it is interesting to notice that it is making progress even when steam turbines are used. The Corporation of Greenock is offering energy for heating hot water during the night time at a farthing per unit. The scheme for ventilation adopted by the author was to draw fresh air into the rooms through air bricks behind the electric fires in the recesses, and to get rid of the vitiated air by means of a wooden grid let into the frieze and communicating with the flue in the external chimney. In all houses in or near towns, work is caused by the dirty or dusty air which surrounds them. It would therefore be better to use a small electric fan and a suitable filter to clean the air. The author points out that the absence of coal fires in a house may make it possible to dispense with one domestic servant, and so not only more than repay the total cost of the electric energy, but also lighten the domestic labour problem.

THE first ordinary meeting of the Electroplaters' and Depositors' Technical Society was held at the Northampton Polytechnic Institute on December 9, when Mr. S. Field read a paper on electrodeposition. He pointed out that there is a great need of organisation and co-operation by those engaged in the science and art of electrodeposition. The history of the art goes back for a hundred years, and the greatest

credit belongs to Faraday for his discovery of the laws of electrolysis. The great progress that has been made of recent years is due to the greater attention that has been given to scientific principles. The systematic research that has been made for addition agents has greatly improved the deposition of tin, lead, iron, cobalt, cadmium and chromium. The practical applications also have increased. A striking application is the copper matrices used for moulding gramophone records. Another recent application is the deposition of iron and nickel so as to repair the worn parts of machinery. When the metal deposited has to withstand mechanical wear, further investigation is needed. There are still too many unsolved problems in the practical processes, some of which would doubtless yield to organised research. The work should be undertaken by men who can devote their whole time to the problems. The position of the electroplating industry is unsatisfactory. There is neither standardisation of nomenclature nor of method. It is hoped to replace the many so-called formulæ for plating solutions by a few comparatively simple scientific formulæ. By organisation, research, standardisation and discussion it is hoped to advance the interests of the whole industry. Prof. F. G. Donnan, president of the Faraday Society, presided at the meeting and welcomed the formation of the Society. It was announced that permission to use rooms in the Northampton Polytechnic for meetings had been obtained.

A GROUP of activities of the Soviet Republics, referred to in a recent issue of the *Bulletin of the U.S.S.R. Society of Cultural Relations with Foreign Countries*, which is of special interest to anthropologists, is connected with the more primitive peoples of what was formerly the Russian Empire. An attempt is to be made to settle the nomads of Kazakistan Republic (Kirghiz Steppes) by the establishment of cultural and educational points which will serve as bases of settlement. The nomad Karagasses of S.W. Irkutz Province, the remnants of the ancient Samoyed tribes who once inhabited the Upper Yenisei, and of whom not more than 500 are left, are to be protected and their culture adapted to modern conditions. Already, by being brought into the co-operative movement, they have been placed in a position to dispose of the products of their hunting expeditions to greater advantage. A Red Cross expedition has been sent out to study their conditions, social, economic, and sanitary, and will pay special attention to the possibilities of making available medical service. Further, a number of cultural bases are to be established among the Samoyeds, Ostyaks, Voguls, Tunguses, and other peoples of the north, which will provide education, medical and veterinary services, and shops for the supply of primary necessities. A special expedition has been sent to the basins of the Lena, Yenisei, and Obi, for the purpose of studying the life of, and conditions among, other small peoples of these areas. A report of the results of these activities will be awaited with interest. It is well known that conditions among these tribes and peoples have for long been bad, and it may be hoped that the material organisation of the Soviets, of which the reports are not encouraging, may be equal to carrying out these measures of amelioration. On the scientific side, to be of any wide utility, much greater expedition in the publication of results than has been shown hitherto is urgently needed.

EARLY skating this winter in Great Britain coupled with the keen November frost and unusually early snow-falls, as well as the strong northerly gales, have given an impression that no such weather has occurred in November for many years, and some would take us back to 1890, when the great frost of 1890–91 commenced on November 25 and lasted until January 22. The Greenwich Observatory records published in the Registrar-General's returns enable a full survey of the daily temperatures for November. The mean for the whole month was 40°·7 F., which is 3°·3 below the normal for the thirty-five years 1881–1915. The mean of the maximum or day temperatures was 46°·0 and the mean of the minimum or night readings was 35°·3. In November 1923 the mean temperature at Greenwich was about 2° colder than this year. The maximum or day temperature was below 40° on 10 days, this year only on 5 days, and the minimum or night temperature fell to 32° or below on 12 nights in 1923 and only on 10 nights this year. The absolute minimum shade temperature in November 1923 was 22°·7, this year 24°·9. The mean temperature for November was also lower than this year in 1921, 1919, 1915, and 1910, but these are the only years since 1880. Snaps of cold weather still seem persistent; on December 4 the thermometer at Greenwich was below the freezing-point throughout the twenty-four hours, and on December 5 the minimum temperature was 21°·4, which is the lowest in December since 1920. An increase is shown in the deaths from influenza, the deaths in London being 22 in the week ending December 5, and in the hundred and five great towns of England and Wales the deaths numbered 100.

PRELIMINARY announcements have now been issued of the Kansas City meeting of the American Association for the Advancement of Science, to be held on December 29–January 2, under the presidency of Prof. M. I. Pupin, of Columbia University, New York. This will be the eighty-second meeting of the Association, but the first occasion on which it has visited Kansas City. General sessions for the whole gathering include the address of the retiring president, Dr. J. McKeen Cattell, on "Some Psychological Experiments"; the fourth annual Sigma Xi Lecture, by President F. D. Farrell, of the Kansas State Agricultural College, on "A Desert becomes a Garden"; an address by Prof. Dayton C. Miller, of the Case School of Applied Science, on "The Michelson-Morley Ether-Drift Experiment, its History and Significance"; the third annual Josiah Willard Gibbs Lecture of the American Mathematical Society, by Prof. James Pierpont, of Yale University, on "Some Modern Views of Space"; discussions on the rôle of science in education and on the relations of engineering to the fundamental sciences; and a lecture by Dr. F. R. Moulton, of the University of Chicago, on "The Origin and Evolution of Worlds." Popular citizens' lectures are also being arranged. The third annual

American Association Prize of 1000 dollars is to be awarded for "some noteworthy contribution to scientific advancement presented at the meeting." Last year this prize was divided between two scientific workers, but this will not be done in future. A publicity office for the release of news to the Press is being organised in association with Science Service, and a comprehensive exhibition of apparatus and books has been arranged.

THE library of the Chemical Society will be closed for the Christmas Holidays at 1 P.M. on Wednesday, December 23, and will reopen at 10 A.M. on Tuesday, December 29.

LIEUT.-GENERAL SIR WILLIAM FURSE, K.C.B., has been appointed Director of the Imperial Institute, in succession to Sir Richard Redmayne, who has been acting as Director during the period of reorganisation and amalgamation with the Imperial Mineral Resources Bureau. Sir Richard now becomes chairman of the Advisory Council of Minerals of the Institute. The appointment of Sir William Furse as Director is in accord with the recommendation of the committee of inquiry into the Imperial Institute, presided over by Mr. W. Ormsby-Gore, that the director of the Institute should be an administrator officer rather than a scientific or technical expert.

BY virtue of the Importation of Plumage (No. 1) Order, 1925, the names of the Common Cormorant and the Common Shag have been added to the Schedule to the Importation of Plumage (Prohibition) Act, 1921, which contains the names of certain birds the plumage of which may be imported without licence. The Board of Trade accordingly desires it to be known that as from December 10 it will be possible to import the plumage of the above-mentioned birds without Board of Trade license.

THE following officers and new members of council of the Royal Physical Society of Edinburgh have been elected for the session 1925-26: *President*: Dr. James Ritchie; *Vice-Presidents*: Dr. Marion I. Newbigin, Prof. J. A. Thomson, Mr. Wm. Williamson; *Secretary*: Mr. H. Maxwell Vickers; *Assistant Secretary*: Prof. J. Russell Greig; *Treasurer*: Mr. Thos. V. Campbell; *Librarian*: Mr. J. Kirke Nash; *New Members of Council*: Mr. T. Cuthbert Day, Prof. T. Hudson Beare, Mr. P. F. Kendall, Prof. Donald C. Matheson, Rev. J. M. M'William.

PROF. A. P. KNIGHT, chairman of the Biological Board of Canada, writes that since his letter on "The Losses in Trout Fry after Distribution" appeared in NATURE of October 17, p. 573, he has had the report on the distribution and losses of trout fry for the past summer (1925). He states that 4000 were distributed in a brook on Prince Edward Island, and at the end of three months, only 27 per cent. of these were alive. The seining showed 300, more or less adult trout present in the stream, 80 fundulus, 31 salmon parr, and 15,000 two-spine stickleback. The presence of these fish natural to the stream, and the lack of adequate supply of natural food, probably accounts fully for the heavy loss of 73 per cent. of the total number distributed.

THE Norman Lockyer Observatory, Sidmouth, is offering a research studentship in astrophysics of the value of 150*l.* per annum for one or two years to a student with a knowledge of spectroscopy. The astronomical and laboratory instruments and material of the Observatory will be at the disposal of such a student for the purposes of practical work; while the large number of negatives of stellar spectra and other observational data which is available for study, together with the extensive library, will provide valuable material for more theoretical research work. The opportunity thus offered should be of great value to a post-graduate student who wishes to apply his knowledge to the study of astrophysical problems and to undertake research work in this subject. Furrther particulars can be obtained from Capt. W. N. McClean, 1 Onslow Gardens, S.W.7.

A CHADWICK lecture on "encephalitis lethargica (sleepy sickness) in England" was delivered by Dr. Salusbury MacNalty on December 9. The lecturer said that this disease made its appearance in England in the spring of 1918 and has since become increasingly prevalent, no less than 5040 cases, with 1419 deaths, occurring in England and Wales last year. For practical purposes the disease is a new phenomenon, though certain epidemics in the past may have been examples of it. It is probably caused by a minute filter-passing micro-organism which causes an inflammatory process in the brain, to which the chief clinical features are due. The question of the evolution of the organism was raised, and the possibility was suggested that the central nervous system of man to-day is more vulnerable than in former centuries, owing to the fatigue and strain of modern life.

AT the Court of Governors of the London Hospital on December 9, the Chairman of the Hospital announced that an anonymous donor had given the large sum of 50,000*l.* for the purposes of medical research in that institution. It is not yet known how the money will be spent. The material for investigation of disease is superabundant at the London Hospital, and it is to be hoped that part at any rate of the money will be expended in individual or concerted effort to solve some of the disease mysteries on the spot where the necessary material exists. It would, in our opinion, be a mistake to fritter away the money, as is often done, in giving grants to a number of young men to produce amateurish work. It is to be hoped that the London Hospital will eventually be able to give a good account of work done and results achieved through assistance afforded by the recent gift.

IN our issue of December 5, p. 828, we printed an announcement from *Science* that the triennial prize for 1925, for the best original work contributing to scientific advancement in the technical applications of electricity offered by the Fondation George Montefiore of Liège, had been awarded to Dr. J. B. Whitehead, of Johns Hopkins University, Baltimore. We have since received information showing that this was one of four awards. The jury of award decided that no memoir submitted merited the single prize of

22,500 francs. The prize was divided and awarded to Mr. F. Creedy, electrical and mechanical engineer, London, for papers on "Some Developments in Multi-speed Cascade Induction Motors" and "Variable Speed Alternating Current Motors without Commutators" (6000 francs); Prof. J. B. Whitehead (4000 francs); and to Mr. Checholowsky, electrical engineer, Antwerp, for his "Study on Operating and Releasing Times of Telephone Relays" (4000 francs). An exceptional prize (2000 francs) for the description of "A New Form of Converter" was awarded to Mr. Raymond Wilmotte, London, in virtue of article 5 of the Foundation permitting the jury to allot a prize to a thesis showing a new idea capable of important developments in electrical engineering.

THE London County Council publishes each year an Annual Report and volumes of Accounts, Estimates, Statistics, etc. These publications, however, do not appeal to the great mass of Londoners, and the Council is therefore publishing a series of booklets on "The London County Council and what it Does for London," of which that entitled "Public Health" (Hodder and Stoughton, Ltd., price 6*d*. net) has recently been received. It deals in three chapters with main drainage, disease prevention, and treatment of disease, respectively, and gives a popular summary of what the Council has done and is doing for these aspects of public health. The booklet is well produced and illustrated, including a map showing the drainage system of London, and is very readable.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Test assistant at the Aeroplane and Armament Experimental Establishment, R.A.F., Martlesham Heath, Suffolk—Secretary to the Air Ministry, Adastral House, Kingsway, W.C.2 (January 4). Technical assistant for the Aerial Photographic Department—Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (January 9). A principal officer of the University of London—Secretary to the Senate, University of London, South Kensington, S.W.7 (February 1). Several men possessing good scientific training and technical experience—Secretary, Chilian Nitrate Committee, Friars House, New Broad Street, E.C.2.

Our Astronomical Column.

DAYLIGHT FIREBALL.—Mr. W. F. Denning writes: "On November 25 at 4^h 5^m P.M., when the sun was shining, a fine meteor was seen by several persons from Cornwall and Devon. It was directed from the south-west and disappeared in the north sky at a somewhat low altitude. It left a train as it passed with moderate velocity across the heavens, and with an estimated duration of 3 seconds. The meteor was quite conspicuous and appeared like a brilliant silver ball descending at an angle of about 35° as seen from Brentor, near Tavistock. The observations are not sufficiently exact for accurate computations to be made of the real path. The height was, however, probably about 77 to 41 miles and the velocity about 34 miles per second; radiant near β Boötis or, farther back in the line of flight, at Corona (233° + 34°). The position of the meteor was over the sea W.N.W. from Fishguard to over Carmarthen in S. Wales. This meteor was the second object of the class observed in sunshine this year, the previous one being on June 4, 4^h 10^m P.M."

THE ERROR OF NEWCOMB'S POSITION OF THE EQUINOX.—All the leading fundamental observatories agree in finding a large correction (amounting to a second of arc) to the position of the equinox given by Newcomb. Prof. Eichelberger and others have concluded that this error is increasing, and that Newcomb's rate of precession is wrong. Mr. R. T. Cullen, in *Monthly Notices of the Roy. Ast. Soc.* (vol. 85, No. 9), gives reasons against this conclusion. He shows that when allowance is made for two changes of practice at Greenwich, the errors of equinox cease to be progressive. These changes are the application of variation of latitude and the introduction of the travelling wire micrometer. The annual part of the variation of latitude causes a systematic shift of the equinox as deduced from observations of the sun, and the use of the travelling wire micrometer has altered mean personality of the observers in the solar observations. Removing the effect of these corrections from the recent observations, the error of Newcomb's equinox since 1851 is found to exhibit no progressive change. The reality of the present error of 1″ in the equinox is not denied, but it is concluded to arise not from a wrong rate of precession, but from the omission from the early solar observations of certain corrections which are applied to the recent ones.

COMETS.—The comets of Van Biesbroeck and Peltier-Wilk are still readily observable with small instruments, the latter being the brighter. The orbits of both comets are now known within narrow limits; that of Van Biesbroeck has been improved by Messrs. G. Merton and A. C. D. Crommelin, using their observations of the morning of December 10. The following elements (referred to the equator) are near the truth, but need slight adjustment.

T	1925 Oct. 1·9848 U.T.	
ω'	94° 2′ 43·1″	1925·0
Ω'	340 3 53·2	
i'	70 18 20·6	
log q	0·185531	

An ephemeris from these elements is not yet available, but that from the Möller-Strömgren orbit will suffice for finding the comet with a little sweeping.

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.	log r.	log Δ.
Dec. 18.	12^h $6·3^m$	25° 48′	0·2615	0·1647
26.	12 2·8	23 50	0·2772	0·1538
Jan. 3.	11 56·5	22 0	0·2929	0·1431
11.	11 47·3	20 17	0·3085	0·1329

The comet is now high enough for observation soon after midnight.

M. A. Schaumasse has discussed in detail the several returns of Borrelly's Comet in recent Nos. of the *Journal des Observateurs*. In No. 10 (Vol. 8) he gives the predicted orbit for the present apparition.

T	1925 Oct. 8·193 U.T.	
ω	352° 25′ 25·42″	1925·0
Ω	77 2 7·10	
i	30 30 40·29	
log q	0·1424289	

Period 6·885463 years.

Recent observations give a correction of +0·60 day to T.

Research Items.

ORIGIN OF ENGLISH GOTHIC STYLE.—An interesting suggestion, which is not without attractions for students of racial psychology, was put forward by Mr. H. E. Irving Taylor to explain the "prependicular" style in English Gothic in a paper presented to the Society of Engineers on December 7. After showing how "curvilinear" tracery has gradually developed from the desire to obviate the objection to unsightly spaces of bare stone which often exist when the original single lancet windows are gathered together as a composite window within one frame, he pointed out that in England the curves of the typical gothic window of France quickly gave way to the "rectilinear" or "perpendicular" framework. The chief explanation of this deviation from the natural development was undoubtedly a suddenly awakened predilection in England for Bible history told pictorially through stained glass. Pictures demand a straight rather than a curved framework, while a long or narrow-paned window best suited the human figure, and as windows increased in size owing to the diminished light given by stained glass, straight rather than curved lines were required to give strength.

THE RITE OF VIGIL OF THE OSAGE TRIBE.—The thirty-ninth annual report of the Bureau of American Ethnology embodies an account by Francis La Flesche of one of the most important rituals of the Osage tribe. The rite of vigil is one of the "seven ceremonial divisions" of the tribal war rites that partake of the seven degrees. These religious rites were formulated during a long period of time in which, according to tribal tradition, the people were established, after a long period of military control, in a civil form of government under hereditary chiefs whose duties included keeping peace and order within the tribe. Two versions of the rite are here given, one belonging to the Puma gens and the other to the Peace gens. A number of songs are interspersed, of which translations are given as well as the music as recorded by Miss Alice Fletcher. The long and impressive ritual leads up to a climax in which an official friend of the initiate foretells the success or the reverse of the tribe from the manner in which a sacred bird lies on the ground as it falls from his hands. This supplicatory rite was employed on various occasions: first collectively by the whole tribe, when all the people cried to Wa-kon'-da, the great creative power, at dawn, noonday, and sunset; second, when the tribe determined on war, a man was chosen to perform the rite for the people as a part of the preparation; third, when a man lost a wife or near relation; fourth, when a man was being initiated into the mysteries of "weaving of the portable shrine," one of the seven degrees of the tribal war rites; and fifth, by the woman appointed to weave the shrine for him. This rite she had to continue all the time she was engaged in weaving, usually four days. On the other hand, the rite when employed in connexion with the death of a relative might last as long as two years.

THE BIOLOGY OF THE COMMON ROCK BARNACLE.—Sven Runnström contributes (*Bergens Mus. Aarbok*, 1924–25), an account of the biology and development of the common rock barnacle of the sea shore, *Balanus balanoides*, based on observations made at the biological station of the Bergen Museum. The eggs are usually fertilised about the end of October and develop in the mantle chamber of the parent from which they swarm out as nauplius larvæ in the first half of March, moulting in a few hours to give rise to the second nauplius stage. How many further moults occur during the free swimming period—which lasts about a month before the cypris stage settles down—was not ascertained. Early in April 1923 the author saw a large swarm of cypris larvæ and suggests that they had just issued from the parental mantle cavities—an exceptional condition. The development of the plates is carefully traced up to the condition in the adult, and a general survey of the formation of the plates in the Balanomorpha is given. The growth of the young Balanus is followed. A week after fixation and metamorphosis, the young Balanus is 1 to 2 mm. in diameter, by the end of June, 3 mm., in the middle of October, 4·5 mm., by the end of November, about 6 mm., and in March, *i.e.* at the end of the first year, 9 mm. in diameter. During the second year, greater growth in height occurs and little extension of the diameter. The ovary and testis of the hermaphrodite individuals are ripe in examples about a year and a half after metamorphosis, *i.e.* in October, and after the larvæ have escaped in the following March the majority of the parents die at the age of two years, but a few may live to the following autumn, *i.e.* to an age of three years, and produce another batch of eggs and young.

THE MOSQUITOES OF EGYPT.—Under the foregoing title, Mr. T. W. Kirkpatrick, senior entomologist to the Egyptian Ministry of Agriculture, has recently published an extensive bulletin on mosquitoes (pp. xii + 224 + 24 plates + 2 maps. Cairo: Government Publications Office, 1925. 30 P.T.). The volume is the outcome of a request by the Anti-Malaria Commission of Egypt that a survey of the mosquitoes of the country be undertaken by the Entomological Section of the Ministry of Agriculture. In June 1924 Mr. Kirkpatrick was detailed for the work and was only given one year for its completion. During this brief period he has managed to gather together a good deal of useful information, and has paved the way for future control measures. Egypt is a country containing but few species of mosquitoes—a fact which is probably due to its isolation by barren deserts. The list of indigenous kinds now includes twenty-two species, or fewer than are met with in Great Britain. The larvæ and pupæ of these various species are all known and described, and practically all the waters wherein they are found gave *p*H values on the side of alkalinity. No correlation was found by Mr. Kirkpatrick between the *p*H values of the waters (which nearly all lay between 7·5 and 9) and the species of mosquitoes found to breed there. The most mosquito-ridden parts of Egypt are the oases of the Western Desert. Next in order would come the Fayum, followed closely by the Canal Zone (excepting Ismailia), and the Wadi Tumilat. The work of the Suez Canal Co., between the years 1901 and 1903, has resulted in the eradication of mosquitoes and the consequent disappearance of malaria from Ismailia and its immediate environs. This locality was once infamous as a most prolific breeding-ground for these insects.

A DISEASE OF DOUGLAS FIR.—The Douglas fir (*Pseudotsuga Douglasii* Carr) is now extensively cultivated in Great Britain, and was at one time regarded as a tree remarkably free from serious epidemic pests. Unfortunately, it is losing its good reputation in this respect. One of its most serious enemies is a fungus now known as *Phomopsis Pseudotsugæ* Wilson, a fungus which has had many other names, but of which a full description, with notes upon its cultivation and upon the synonymy, has recently been published by Dr. Malcolm Wilson, reader in mycology, University of Edinburgh, as Bulletin No. 6 of the Forestry Commission. The disease is most

dangerous to young plants, so that infection in the nursery particularly has to be guarded against. Cankers are fairly frequent not far above ground level, and there is considerable reason to assume entry of the organism through a wound. Mechanical damage when planting, or during forestry operations generally, is evidently a source of danger, and the removal of dead wood and pruning operations need to be carried out with care. Rare instances of the disease are also recorded by Dr. Wilson for Japanese larch, European larch, and *Abies grandis* Lindl.

AIR-COOLED STORAGE ROOMS FOR APPLES.—Special Bulletin No. 146 of the Agricultural Experimental Station of Michigan State College, by Roy E. Marshall, is a description of the warehouses used for the storage of apples in Michigan. A detailed account is given of the principles involved in the air-cooled storages of apples. This method is extensively employed by growers and growers' organisations with less than about 25,000 bushels of fruit for storage, as the cost of cooling the rooms by mechanical refrigeration in such cases becomes excessive. The construction and insulation of the storage houses is discussed in detail. Especial attention has to be paid to ventilation, for upon this depends the cooling, the regulation of the humidity, and the removal of deleterious gases given off by the fruits. The method adopted is to take air in through several openings or air intakes built in the walls just above the ground level or near the floor of the structure, and provide outlets through ventilators which extend from the ceiling of the fruit room out through the roof of the building. Both inlet and outlet flues are equipped with tight doors which serve as dampers to permit either the entrance of, or to exclude, the outdoor air. When the outdoor air temperature is lower than that in the storage room or of the fruit, the air inlet doors and those of the outlet flues may be opened, permitting the warmer air of the storage room to pass out through the flues. All openings are tightly closed whenever outdoor temperature is higher than that inside the room. It is stated that the most satisfactory humidity conditions are obtained with earth or clay floors to the stores. A relative humidity of 85 per cent. is recommended. To increase the humidity the floors are wetted, and to decrease the humidity the room is ventilated with colder air.

SHOT-FIRING IN MINES.—Scientific research is very often in the nature of a gamble. The capable professional researcher is sometimes much more interested in some private research than he is in his routine work. This does not mean that he neglects his routine work. On the contrary, he may do it remarkably well, but he does not devote to it labour outside his official hours. The prizes obtainable by success in private research are of far greater value than those obtainable by successful research on lines laid down by a committee. It is therefore politic from every point of view that successful team research should be encouraged. Such a research is recorded in Paper No. 11 of the Safety in Mines Research Board (London: H.M. Stationery Office, 1925, 1s. net). This paper describes a valuable research on "Electrical Exploders for Shot-Firing in Coal Mines." The means generally employed for detonating an explosive are the electric detonator and the magneto-exploder. In this research not only the minimum currents required to ignite detonators and to ignite fire damp are investigated, but also novel means are suggested for generating currents which will lie between these limits. It is found, for example, that if a broad band of copper of suitable thickness be wrapped round the armature core of a high voltage magneto-exploder, before winding, the machine can be made inherently safe. Machines constructed in this way have proved entirely satisfactory. The designs of existing machines are criticised, and improved designs are suggested. In particular the advantages of using a small rotating magnet of cobalt steel and a stationary armature winding are pointed out. The possible use of modern dry batteries for shot-firing is considered. A battery of eight dry cells weighing only a few ounces would have a life of about three months when used for low voltage fuse-head ignition. A new form of exploder consisting of a single winding and a single dry battery is described and has been found to be safe and satisfactory in everyday use with high voltage fuse-heads. The experimenters and the sub-committee have to be congratulated on the results of their labours.

OXIDES OF BARIUM.—An account of a new peroxide of barium by M. Carlton is contained in the *Journal of the Chemical Society* for October. It is prepared by the action of an excess of hydrogen peroxide on barium hydroxide solution cooled below 20° C. The product is an unstable cream-coloured powder, which has vigorous oxidising properties. The peroxide was analysed by heating in nitrogen, passing the oxygen liberated over weighed heated copper, and weighing the residue as barium dioxide. When carbon dioxide was used the residue consisted of barium carbonate. Wet analysis was carried out with acid potassium permanganate solution. The results of analysis indicated the formula BaO_3.

LATENT HEAT OF OXYGEN-NITROGEN MIXTURES.—Experiments on the latent heat of vaporisation of liquid oxygen-nitrogen mixtures are described in the *Proceedings of the American Academy of Arts and Sciences*, vol. 60, No. 4, October 1925, by L. I. Dana. A definition of the latent heat of vaporisation of mixtures is adopted which corresponds with the production of vapour of the same composition as the liquid. A special apparatus, with electrical heating, was used. The results are tabulated, and a curve is drawn showing the latent heats from pure nitrogen to pure oxygen, mixtures being intermediate between these limits. The latent heat of evaporation of liquid oxygen (1 atm.) was found to be 51·01 gm. cal. (15°), that of liquid nitrogen 47·74 gm. cal. There is a maximum on the curve at 51·23 gm. cal. corresponding with 80 per cent. oxygen in the mixture.

ELECTRO-DEPOSITION OF CHROMIUM.—At the Royal Society soirée last May, much attention was attracted by an exhibit of chromium plated objects by the Metropolitan Vickers Company. We learn from a paragraph in "Science Notes" in the December issue of the *Forum* that the Westinghouse Company of America has now been exhibiting many applications of this metal. The electro-deposition of chromium is accompanied by great difficulties, and although it is a simple matter to obtain a deposit, yet the practical production of smooth and uniform deposits has only been achieved in a very few instances. The surface when produced under the best conditions is very bright and silvery, although with a bluish tinge. It is remarkable for its resistance to tarnishing agents even in very impure atmospheres. The Westinghouse Company is using a thin deposit of chromium on the reflectors for automobile headlights. Recent experiments described in a paper to Section B (Chemistry) of the British Association show that the resistance of chromium to attack by sea-water or by spray is very high, a fact which was not at first expected, as it is known that the metal is easily attacked by hydrochloric acid. It appears that most of the difficulties in the production of smooth chromium deposits can be overcome. The great hardness of the metal, in addition to its superior power of resisting corrosion, gives it advantages over nickel.

The Oudtshoorn Meeting of the South African Association for the Advancement of Science.

THE twenty-third annual meeting of the South African Association for the Advancement of Science was held at Oudtshoorn on July 6-11, 1925, under the presidency of the Right Hon. General J. C. Smuts. The meeting was well attended, eighty papers were read, and there was a number of exhibits. Joint meetings of sections were held for Prof. C. G. S. de Villiers' demonstration of Rudolf Martin's anthropometrical instrumentarium and for Prof. H. B. Fantham's paper on "Some Factors in Eugenics, together with Notes on some South African Cases." After the conclusion of his presidential address, Gen. Smuts presented the South Africa Medal and grant to Dr. R. B. Young, professor of geology in the University of the Witwatersrand. A popular lecture on "Fossilised South Africans" was given by Prof. R. A. Dart, and a public lecture on "Thomas Henry Huxley, his Life and Work" (in honour of the centenary of Huxley's birth) was delivered by Dr. Annie Porter. There was a reception by the Mayor and Mayoress of Oudtshoorn and visits to various places of scientific interest in the neighbourhood.

The president of the Association, General J. C. Smuts, gave as his presidential address, "South Africa in Science" (see NATURE, August 15, p. 245). He pointed out the desirability of a South African, as opposed to a European, point of view in science. Using the Wegener hypothesis of continental drift and Darwin's hypothesis of a southern and not northern origin of the fauna and flora of Africa, the relations of South Africa with other southern land masses were traced, its affinities being rather with South America, India, and Australia than with the northern hemisphere. The peculiar Cape flora appears to be rather a survival of the great flora of a southern hemisphere than the remnants of one of northern origin. The geology of South Africa is paralleled, both now and in Mesozoic times, with that of South America. The same applies to zoology. In palæontology there is more need for comparative study. Meteorology and climatology were considered, and the need for an Antarctic meteorological station for South America, South Africa, and Australia was indicated. The address concluded with a plea for the encouragement and Government recognition of research.

The presidential address to Section A was delivered by Mr. R. J. van Reenen on "Development of Irrigation in the Union of South Africa." The development of various phases of irrigation, irrigation legislation, and the institution of irrigation districts were considered. The rôle of the State in relation to irrigated land settlement was discussed, and it was urged that the State should settle irrigable land and privately owned land in excess of the owner's ability to cultivate. State loans, the growth of capital invested in irrigation, and the need for providing settlers were mentioned. Further necessary developments were noted, such as improved marketing facilities, encouragement of co-operation, and provision of factories for utilising raw products. The need of systematised water storage and its value to the stock farmer was emphasised, and a plea for more economic use of water generally was advanced.

"Soil Formation and Classification" was the subject of Dr. B. de C. Marchand's presidential address to Section B. The origin, properties, composition, and distribution of soils were discussed. The rôle of hydrolysis in soil formation was indicated. The degree of reaction, fate of the products, admixture and influence of organic matter, residue of plant growth, all determine the nature of soil. Climate as the determinant of the rate and nature of mineral decomposition, and the transference of substances from one layer to another, were discussed, and also the effect of arid and high rainfall conditions. Climatic soil types in the Transvaal and the influence of climate and rainfall there on soil formation, where the soils are largely endodynamomorphic, were fully treated. The general tendency is to the formation of lateritic types of soil. One important European soil-forming factor, earthworms, is absent from the Transvaal. The fundamental classification of soils of the country is an essential preliminary to a systematic agricultural survey.

The president of Section C, Mr. E. Parish, dealt with "Problems in Agriculture in South Africa," more from the point of view of scientific agriculture than agricultural science. The adoption of mixed farming was advocated as of primary importance, the present system of crop production being compared with what occurred in the United States when land was plentiful and soil depletion and spoliation ensued. Conservation in South Africa is essential. Farming can be intensified by increasing production per unit of labour and by the supply of agricultural machinery at lower rates. Farming under irrigation was considered and the need of suitable crops in irrigated areas indicated. Technical education is a necessity for farmers, and specialised technical training is required for different sections of farming. Provision for agricultural research, freed from routine and administrative work, was urged.

Prof. J. E. Duerden, president of Section D, took as his subject, "Genetics and Eugenics in South Africa: Heredity and Environment." The special problems of South Africa in relation to heredity and environment in connexion with human beings and domestic stock were outlined. Hereditary constitution and environmental influences are both important, and change in one affects the other. In agricultural stock, blood improvement is going on, but better conditions of maintenance are necessary. Variations in parts of ostrich plumes and merino wool show the diversity resulting from differences in nutrition, though from the same germ plasm. The limitations of germ plasm and environment were discussed. The interactions of the white race and the Bantu were considered; "indigent" whites were regarded as products of unfavourable environment and the presence of the primitive native. The rôle of the white races in South Africa was considered to be that of a benevolent aristocracy of ability. The extreme importance of genetics and eugenics to South Africa was emphasised.

"The Present Position of Anthropology in South Africa" was the presidential address to Section E, delivered by Prof. R. A. Dart, who pointed out that in South Africa every one is bound to have anthropological interests. A brief historical résumé of the discoveries at Boskop, Oldaway, Broken Hill, Zitzikama, and Taungs showed that the negroid is not the primitive South African stock. The various fields of anthropological study in South Africa were noted. Philology needs attention in view of numerous native tongues, official bilingualism, Arab, Malay, and Asiatic populations. Ethnology needs much study, as do also native music and arts. Physical anthropology deserves attention in order to obtain an understanding of the laws that govern racial divergence. The address concluded with an appeal for fostering and retaining an African and not a European outlook in regard to African problems.

Prof. H. A. Reyburn chose "Psychology and

Grammar" as the subject of his presidential address to Section F. He discussed language from the psychological point of view, showing that in grammar, confusion arises between the mechanism of the language and the function that mechanism fulfils. Accidence and syntax, considered psychologically, break down these distinctions. The definitions of some of the parts of speech were discussed and their unsatisfactory nature demonstrated. The conception of different grammatical categories, with reference more especially to the work of Jesperson, was critically examined. Language as applied logic was discountenanced and a plea made for the psychological study of language. A suggested scheme for the re-study and re-writing of grammar was outlined.

It is only possible to note briefly the interesting papers and exhibits given before the various sections.

In Section A, Prof. G. H. Stanley gave a paper on a method of determining the relative resistance of paving materials to wear by subjecting flat pieces of equal area of the various materials to the grinding action of horizontally rotating steel discs. Mr. R. J. van Reenen gave an account of the apparent regularity of wet and dry years in South-West Africa, a series of dry years occurring at thirty-five years' intervals, coinciding with the Brückner cycle. Dr. J. Schonken discussed effective rainfall. A paper by Mr. A. G. Hoyer dealt with star streaming and the structure of the universe.

In Section B, Dr. B. de C. Marchand and Mr. C. R. van der Merwe gave an account of the fractions separated by mechanical analysis from some Transvaal soils, the differences between the clays from the red and black soils being determined. Mr. W. Torrance described a prehnite vein in the dolerite at Grootfontein, Middelburg, C.P., due to percolating waters depositing their load in a fissure in the dolerite. Mr. G. Ingham contributed a paper on the relative availability of phosphatic fertilisers on acid and non-acid soils, this being generally low on acid soils and high on non-acid ones. A note on the banded ingredients of South African coal was given by Prof. J. A. Wilkinson. Mr. B. J. Smit and Dr. T. J. Naude gave a paper on fumigation with liquid hydrocyanic acid, and Mr. E. George presented papers on phenol 5-methyl-isatein, phenol phthalamein, phenol umbellein, and resorcinol umbellein, and on the preparation of umbelliferone.

In Section C, Dr. E. M. Robinson described the bacteria of the *Clostridium botulinum* C type and their distribution, with notes on his work on lamsiekte. Mr. J. F. V. Phillips gave an account of the ecology of *Platylophus trifoliatus* as seen in the Knysna forest. Mr. L. Verwoerd described some South African Hymenogastraceæ. Prof. P. A. van der Bijl described some new South African fungi and also gave a preliminary report on the fungi of the Knysna district in his herbarium. A paper on the retardation of the ripening processes of pears at high temperatures was contributed by Dr. F. J. de Villiers, who finds that 30° C. appears to be the optimum for ripening. Mr. J. F. V. Phillips contributed a paper on plant phytometers and the use of indigenous tree seedlings in this capacity in practical forestry. Mr. A. Stead presented a note on the fructifying action of heat on the pine-apple; so many as twenty small fruits have been obtained from one plant. Dr. F. J. de Villiers discussed the differential freezing of pear tissues, and Miss E. Stephens demonstrated the plants obtained by her from cultures of dried mud.

In Section D, Prof. H. B. Fantham gave an account of some more parasitic Protozoa found by him in South Africa, including herpetomonads from new molluscan hosts and flagellates from various veld rodents that transmit plague. The interesting ciliate, Discomorpha, has been obtained from the intestine of a horse. Prof. E. H. Cluver gave a paper on cardiac mortality in Johannesburg and at the Coast, showing from statistics that such mortality in Johannesburg, despite its altitude, is less than at the Coast. Miss N. F. Paterson summarised her experiments on the effects of differences of hydrogen-ion concentrations on the development and longevity of certain mosquito larvæ. Prof. J. E. Duerden and Mr. V. Bosman gave an account of their biometric analysis of wool fibres, establishing the proportion of various sizes of fibres in a staple. Prof. E. Warren dealt with amitosis and fragmentation of nuclei in the development of the spider, Palystes, in which four types of chromosomes occur. Prof. C. G. S. de Villiers gave an account of recent researches on the breast-shoulder apparatus of certain Anura, both living and extinct. Prof. R. W. M. Mettam gave a note on the occurrence of a muscle of doubtful origin found by him in the foot of a horse. Mr. H. H. Curson notified the occurrence of *Trypanosoma vivax* in Bechuanaland, this being one of the three parasites of nagana. The histology of the lining of the stomach of the ostrich was described by Miss G. T. Brock. Prof. A. J. T. Janse described the anatomy of a gynandrous form of the butterfly, *Precis sophia*. Mr. J. F. V. Phillips gave an account of the natural history of the herd of Knysna elephant. The locust-fungus, *Empusa grylli*, and its effects on its host were described by Dr. S. H. Skaife, who finds that the epidemic among the locusts stops on the cessation of the rains. Dr. F. G. Cawston gave a note on the radulæ of some fresh water molluscs. Prof. C. G. S. de Villiers gave a demonstration of Rudolf Martin's improved instrumentarium for anthropometrical investigation. Prof. H. B. Fantham and Miss N. F. Paterson reported on their further work on the Protozoa of certain South African soils, in which the seasonal variation in the protozoal fauna of water-logged soils and those of waterlogged soils from mining areas were noted, as were various environmental effects. Prof. Janse gave a paper on the systematics of the Lepidoptera. Dr. Annie Porter reported that *Limnæa truncatula* serves as an additional host for *Fasciola hepatica* in South Africa.

A joint meeting of Sections C, D, E, and F was held for a paper by Prof. H. B. Fantham on "Some Factors in Eugenics, together with Notes on some South African Cases." Selective birth-rate and selective death-rate, differential birth-rate in different strata of society, and racial admixture were discussed, and notes on some cases of inheritance of certain well-marked physical and mental characteristics and of the results of racial admixture were given.

In Section E, Mr. C. van Riet Lowe gave an account of the kinds and distribution of stone implement workshops in the Orange Free State. Mr. A. J. H. Goodwin discussed the Capsian affinities of the South African later Stone Age culture; he considers that the Smithfield and Pygmy industries in South Africa are culturally the same as the North African Capsian one. Prof. R. A. Dart described the round stone culture in South Africa. An exhibit of copies of numerous Bushman paintings from the Kei River was arranged by Brother Otto, and Prof. E. H. L. Schwarz exhibited tracings of Bushman paintings from the Clanwilliam District. Mr. J. Hewitt's paper dealt with stone implements from various sites in the Cape Province, representing different cultural developments. Prof. Dart gave a note on Makapansgat, where beds of fragments of fossilised bones, too small for identification, occur. Mr. G. D. Laing gave a further report on the Zitzikama material and described another skeletal find in an ancient Rooiberg

mine-working. Mrs. J. D. Laing contributed remarks on the temporo-mandibular region in the Boskop, Strandlooper, Bushman, and negro peoples. Anthropometric measurements of the skeleton of the Boskop race were given by Mr. H. S. Gear, and the brain of the Boskop race was discussed by Prof. Dart, who also exhibited casts of the Taungs skull and a Boskopoid skull obtained by Prof. M. R. Drennan from a subject in his dissecting-room at the University of Cape Town. Miss E. Dora Earthy gave a paper on the rôle of the father's sister among the Va-Lenge of Gazaland. Mrs. A. W. Hoernlé discussed the sib in Southern Bantu marriage ceremonies, showing the deep-seated nature of the relation of the sibs and their relation to lobola, which involves the contracting parties, the sibs, and the ancestral spirits. Mr. E. C. Randell described a supernumerary molar tooth in a Bantu. Mr. H. Q. F. Thompson described the custom of amputation of part of one of the fingers by the Zulu-Xosa groups of Bantu. Mr. G. D. Laing gave an initial report on somatometric investigations among the natives recruited for the Witwatersrand. Mr. C. Dawson described the Neanderthaloid foot of the Zuurberg Bushman. Father Huss and Brother Otto discussed the origin of Bushman paintings at the Kei River. Mr. I. Schapera gave a paper on stylistic affinities of Bushman art, stating the criteria for comparison of Capsian, North African, and Bushman art. Mr. F. R. Paver traced Asiatic influence on early South-East African development from various records. Mr. S. Zuckerman gave a note on a superficial scraping of the floor of a rock shelter in the Cape Midlands.

In Section F, the normative character of ethics was discussed by Prof. G. H. T. Malan. Mr. C. Graham Botha gave a paper on the distribution of South African fauna in relation to place-names, indicating the former distribution of animals now extinct. He also described social customs in South Africa during the eighteenth century, such being influenced both by Holland and the East Indies. Prof. R. D. Nauta gave a paper on the Spanish Cid. Dr. F. G. Cawston gave notes on some removable causes of unemployment and crime. Mrs. C. G. Botha described some minor experiments in the unconscious. Dr. A. Barradas gave statistics of mortality in Lourenço Marques for the past seventy years. Mrs. Mabel Palmer traced the evolution of the organisation and technique of adult non-vocational education. Mr. C. S. Richards gave a critical paper on the Kammerer-Vissering Report and the position of the Reserve Bank, the proper function of which was outlined.

The next annual meeting of the Association will be held at Pretoria, under the presidency of Dr. E. T. Mellor, in July 1926. H. B. FANTHAM.

Transmission of Power.

AN interesting analysis of the problem of the transmission of power is contained in a paper read by Mr. G. Constantinesco before the North-East Coast Institution of Engineers and Shipbuilders on December 4. The author is well known in engineering circles as the inventor of the method of transmitting energy by "wave transmission," in which the liquid does not circulate. He formulates the following fundamental laws governing any transmission of power: (1) Energy can be transmitted from one point to another only at the expense of a definite loss. (2) There is a minimum loss in any given system or method of transmission which cannot be decreased by any conceivable improvement in the system. (3) The transport of energy is possible only by circulation or oscillation, and there is a minimum amount of matter necessary for such transport. Such minimum is also independent of present or future methods of transmission, and depends only on the amount of energy, distance of transport, and change of form of the energy.

There are three broad classes of systems of power transmission, namely, mechanical, fluid, and electric. The author takes a few random problems of power transmission and first shows that the efficiency curve for any electric system can be drawn irrespective of the particulars of the transmission considered. The curve appears as an invariant when the units of measure are taken as the minimum possible loss and the critical voltage for which this minimum loss occurs. He then gives a lengthy investigation of hydraulic transmission and shows that the whole curve of efficiency is also an invariant, and that once the maximum "peak" possible efficiency is known, the whole behaviour of the transmission can be predicted. There is a handicap to high efficiencies in fluid transmissions owing to the unavoidable loss in changing the energy abruptly from one form to another. Thus, if the energy is available at the shaft of a prime mover in the form of a rotating torque, the transformation of this into hydraulic energy is accompanied by a definite loss, which is independent of the means by which the transformation is made. The peak efficiency of transformation depends only on fixed constants defining the fluid itself. The same conclusions are reached in the transmission of energy by use of gases.

The efficiency curves for electric, hydraulic, and gas transmissions show the same fundamental property, namely, they are invariables of very nearly the same shape.

Experimental data regarding mechanical systems are not complete, but Mr. Constantinesco thinks that the figures would not be very different from those relating to electric and hydraulic transmissions. Peak efficiencies of a very high order are found to-day only in mechanical transmissions. There is an absolute limit to the possible peak efficiency which the author is inclined to think has already been reached in some mechanical transmissions such as link motions, gear wheels, and the like. Efficiencies of the order of 95 per cent. are practical possibilities for almost any sound mechanical transmission of moderate power when carefully designed. Hydraulic and electric transmissions may be credited with 85 per cent. This small difference in peak efficiencies is sufficient to make a relatively important difference in average efficiencies. From the efficiency point of view alone, there appears to be no doubt that mechanical transmissions are superior to electric or fluid transmissions, and if the latter can replace in certain cases mechanical transmissions, it is only from the point of view of convenience.

With one single exception, in each field, electric, fluid, and mechanical, rotary power cannot be transmitted from one point to another except by periodic or intermittent impulses. The exception is when the power is transmitted through a material body rotating at uniform speed and transmitting a constant torque along its axis of rotation. A more general statement of this *postulatum* is: "Any transmission in which the output energy differs in shape from the input cannot be accomplished without the power being transformed at one stage or another into periodic impulses." The author considers that the relations which are the basis of electric current theory form the

fundamentals of a new science of applied mechanics. The application of these relations to long-distance transmissions by liquid columns and to acoustics has enabled him to duplicate practically every manifestation of electric transmissions, and led to the invention of the "wave transmission" method of transmitting energy and also to the synchronising of machine guns on aeroplanes so as to enable them to fire through the propeller.

Electric transmissions are at present in want of higher peak efficiencies in order to come up to the level of their mechanical equivalents. No doubt progress is still possible provided electrical engineers will not develop the habit of mechanical engineers of ignoring the fact that there is still plenty of work to do, both theoretical and practical, on old neglected avenues. Fluid transmissions have a fairly uphill task to overtake either electric or direct mechanical transmissions. Mechanical transmission at present seems to offer the most promising field for obtaining immediate and substantial results.

Mr. Constantinesco's paper is long, and full of speculations which cannot fail to be of interest to engineers who are concerned with the many problems of power transmission.

Food and Fattening of Oysters.[1]

THE material eaten by an oyster consists of minute organisms and other matter floating freely in the water, and present in the surface soil on which oysters occur. Mr. R. E. Savage has studied qualitatively and quantitatively the contents of the stomachs of oysters in relation only to the organisms and material found floating near the bottom of the sea in two localities, namely, the Main Channels of the River Ore in Suffolk and the adjacent Butley Creek. These situations were chosen because there was reason to believe that oysters fattened much more readily in the Creek than in the Channels. Data were obtained by exhausting the alimentary canals of usually six oysters once a month and taking one ten-minute sample of plankton from each bed once a month for a period of 13 months. From his restricted material, the author has extracted highly interesting facts and results, but the value of the latter is diminished by the absence of continuous contributory—and not necessarily quantitative—observations on the beds. In any estuarine problem the influence of tide and time should not be ignored. The author found that the material ingested by the oysters in the localities examined consisted of 90 per cent. or more inanimate matter ("organic detritus"), and a searching volumetric and numerical analysis of the animate food is given. He also finds that the feeding period extended from July to October or November, with a short season of brisk feeding during August and September, and that in the remainder of the year little food was found. The suggestion adopted that the absence of feeding in winter may be due to the effect of low temperatures on the ciliary and muscular feeding mechanisms is well worth definite examination. There was a definite difference in the quality and quantity of the animate food in the situations chosen.

In analysing the results for these two regions, the author finds (1) that the total food consumed is approximately equal in volume, but that (2) the percentage volume (quantity) of animate food is four times as large in the Creek (where fattening occurs) as in the Channels (where fattening is *less satisfactory*; the italics are ours), and that (3) the proportion of diatoms in the food of oysters from the Creek is greatly in excess of animals, while the proportion of animals in the food of Channel oysters is greater than that of diatoms. No proof is produced of better results in fattening in the Creek, where the food was mostly diatoms, and proof is unfortunately required since "fattening" is, in our present knowledge, highly capricious. The author concludes "that there is an apparent relation between consumption of diatoms and fattening," and "suggests that fattening is due to diatoms and growth to inanimate food."

The suggestion that fattening is due to diatoms (in this case mainly Nitschiella) is probably true for the particular locality studied, but on the author's data the difference in quantity of animate food might equally well account for a difference between "fattening" and "less satisfactory fattening." The reviewer holds the view that the problem of fattening will not be solved by a mere consideration of food. Fattening is chiefly a storing up of the surplus products of metabolism—mainly as glycogen—presumably for general purposes, but is also in part due to proliferation of the sex-organ. Hence the whole activities of the living animal, namely, growth, breeding, environmental conditions, as well as feeding, must be considered. A simple illustration will prove this: oysters which have recently grown a great deal of shell (and have been actively breeding) have mostly poor "fishes," *i.e.* are not fattened, whereas poorly grown dumpy or semi-dumpy oysters, taken in nearly equal proportions *in the same hauls of the dredges* as the well-grown ones, have large plump fishes, that is, are very well fattened, as the following figures,[2] which have been confirmed in larger numbers, will show:

Thirty-one oysters of average size 66 mm. × 67 mm. and average new growth 20 mm. had an average "fish" weight of 5·3 grams, whereas dumpy oysters ranging to a maximum size of 53 mm. × 68 mm. and with an average growth of 6 mm. had an average fish weight of 7·5 grams. Larger oysters 83 mm. × 81 mm. with average new growth 29 mm. had average fish weight 9·7 grams, but a typical large dumpy oyster 68 mm. × 75 mm. with 5 mm. new growth had a fish-weight of 13·5 grams.

J. H. O.

[1] Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 8, No. 1, 1925. The Food of the Oyster. By R. E. Savage. Pp. 50+3 plates. (London: H.M. Stationery Office, 1925.) 8s. net.

[2] Taken from Report on a Survey of the Oyster Beds in the Estuary of the Fal with Notes on the Biology of the Oyster, p. 91, January 1925. See also NATURE September 26, p. 486, where a review of the Summary published for the Falmouth and Truro Corporations was noticed.

Voltaire and Medicine.

IN the first part of a paper on "Voltaire and Medicine" read before the section of the History of Medicine of the Royal Society of Medicine on October 21, the president, Dr. J. D. Rolleston, quoted the words of the celebrated Berlin physiologist Prof. Emil Du Bois-Reymond, who in an address on Voltaire in his relation to natural science, attributed the neglect of this philosopher in the nineteenth century to the apparently paradoxical fact that we were all in a sense Voltairians without knowing it. "The ideals of tolerance, mental freedom, dignity and justice for which Voltaire had fought . . . had become a natural element of life like the air we breathe, which we only notice when we are deprived of it." Dr. Rolleston's paper dealt with Voltaire's relations to individual doctors and the medical profession as a whole, including some account of Voltaire's various illnesses. He contracted a severe attack of small-pox at the age of twenty-nine years, but apart from influenza and pneumonia he does not appear to have had any other

acute infectious disease. He was subject to chronic dyspepsia from an early age, and frequently suffered from catarrhal bronchitis, often associated with deafness and aphonia. He frequently complained of febrile attacks which may have been malarial in origin. His death at the age of eighty-four years was probably due to uræmia following cystitis secondary to enlargement of the prostate which was found on post-mortem examination.

Voltaire was brought into contact with medical men on numerous occasions, both professionally and socially. During his stay in London (1726–29) he appears to have been acquainted with several leading medical men of the time, especially Sir Hans Sloane, Mead and Freind, as well as with other medical fellows of the Royal Society, especially Arbuthnot and Pemberton. He was himself elected F.R.S. in 1743. Among the numerous doctors whom Voltaire consulted the best known are Silva, physician to Louis XIV.; Boerhaave, whose name frequently occurs in Voltaire's works, especially in connexion with chemistry; and Tronchin, whom he described as the greatest physician in Europe and the only one who understood Nature.

Voltaire's works, particularly his correspondence, the "Dictionnaire Philosophique," his tales, and to a less extent his historical works, miscellaneous essays and pamphlets, abound with references to the medical profession. Many allusions are to be found to the masters of medicine, such as Hippocrates, Rhazes, Servetus, Harvey and Sydenham, as well as to celebrated anatomists such as Vesalius, Ruysch, Bartholin and Vieussens, but the medical works with which Voltaire was most familiar was probably that of Astruc on the venereal disease. The passages in which he indulges his satirical humour at the expense of the profession are few and unimportant in comparison with those in which he expresses his admiration and gratitude, and apart from the tales are chiefly to be found in his correspondence, where they are probably not to be taken too seriously. On the other hand, Voltaire was scathing in his denunciation of quacks, and vented his ridicule on many superstitions and erroneous doctrines connected with normal and morbid processes, particularly spontaneous generation, which was upheld by Needham and combated by Spallanzani.

University and Educational Intelligence.

GLASGOW.—The University Court on Thursday, December 10, appointed to the chair of natural philosophy Dr. Edward Taylor Jones, professor of physics in the University College of North Wales, Bangor. In 1899 he succeeded Prof. Andrew Gray in the latter chair, and now succeeds him in Glasgow also. A distinguished pupil of Prof. Gray at Bangor, he graduated with the highest honours in the University of London. With the aid of an "1851 Exhibition" research scholarship, he proceeded to the University of Berlin, where he worked under Profs. Kundt, du Bois, Rubens, von Helmholtz, Planck, and Fuchs. His important memoir on "Electromagnetic Stress" procured him his doctorate. Returning to Bangor in 1896 he was appointed lecturer, and afterwards professor of physics. He has also held in succession the administrative posts of Dean and Chairman of the Faculty of Science, representative of the Senate on the Council, member of the University Court of the University of Wales, and Vice-Principal of the College. Prof. Taylor Jones has published some thirty papers on electrical subjects, in particular on electrical oscillations, coupled circuits, the singing electric arc, and the triode valve generator, all having important bearings on wireless telegraphy and telephony. He is recognised as having placed the theory of the induction-coil on a sure basis, and his book on that subject is the standard treatise. He also co-operated with the Internal Combustion Engine Sub-Committee of the Advisory Committee for Aeronautics. He will take up his duties in Glasgow at the beginning of next term. He is fifty-two years of age.

LIVERPOOL.—Miss Winifred E. Frost has been appointed to the Herdman Memorial Scholarship for 1925.

Dr. T. P. Hilditch has been appointed to the Campbell Brown chair of industrial chemistry. The appointment is in the first instance with special reference to research on oils, fats, and waxes. Prof. S. H. Gaiger, of the Veterinary College, Edinburgh, has been appointed to the William Prescot chair of the care of animals with special reference to the causation and prevention of disease.

In a lecture delivered on December 4, Prof. G. H. Henderson, of the University of Glasgow, advocated that chemists should endeavour to educate the public to the value of their profession to the community and its importance in national welfare. He would like to see a unified body controlling all chemists and speaking for the profession as a whole.

MANCHESTER.—Prof. A. H. Gibson has been elected Dean of the Faculty of Science. The following appointments have been made:—Dr. J. C. Smith to be assistant lecturer in chemistry; and Mr. J. C. Brierley to be assistant lecturer in engineering drawing (Faculty of Technology). Dr. E. N. Mottram has been awarded the Sir Clements Royd Memorial Scholarship in chemistry.

PROGRAMMES have now been issued of the annual meetings of the Science Masters' Association and of the Association of Women Science Teachers. The Science Masters' Association meets at King's College for Women, London, on January 5-7, under the presidency of the Right Rev. C. W. Barnes, Lord Bishop of Birmingham. The presidential address will be delivered on the first evening of the gathering, and the general programme includes lectures by Dr. T. Slater Price on "The Sensitivity of the Photographic Plate," and by Prof. Leonard Hill on "Sunshine, Open Air, and Health," and discussions on "Science and Citizenship," to be opened by Mr. W. D. Eggar and Mr. O. H. Latter, and on school science examinations, to be opened by Mr. D. J. Berridge, Mr. E. Nightingale and Mr. E. G. Laws. Invitations have been accepted for parties to visit the laboratories of the General Electric Company and also the National Physical Laboratory, while there will be the usual exhibition of apparatus and books by members of the Association and by publishers and instrument-makers. The annual general meeting of the Association of Women Science Teachers will be held on February 6 at St. Paul's Girls' School, London. The programme includes a demonstration by the Visual Education Society of educational films and an address by Miss Coward on the teaching of hygiene in schools. Miss Bond is to move a resolution "that in view of the fact that for the majority of pupils the General School Examination (School Certificate) terminates their study of Botany, it is desirable that the Syllabus in Botany be amended as follows: (1) The number of Families should be very much reduced, and the ability to use a Flora should take the place of most of this detailed knowledge. (2) The life histories of, at least, one Alga and a Fern should be included in the Syllabus. These should be simply treated so as to need only a small amount of microscopic work."

Early Science at Oxford.

December 21, 1683. Mr. Ballard was desir'd to try some experiments, in ye Holy daies, in order to the solution of the question: Whether cast-Iron will draw ye needle, as readily as that which is forg'd? Dr. Smith was pleased to shew us some observations, which he made in his voyage to Constantinople, año 1668; when among other things, ye Dr. observed a great number of Porcpisces, which almost coverd a good part of ye Propontis, from ye Seraglio point, towards ye Islands, that lye over against the bay of Nicomedia; for which reason (as also because he never heard that any Dolphins are caught there by ye Greeks, the good fishermen; nor saw any sold in their Markets) He thinkes, that Solinus, cap 12, is to be understood of Porcpisces, not of Dolphins; although he says (speaking of ye Bosphorus, and Hellespont) hæc profunda *Delphinas* plurimos habent. As for that vast quantity of water, which runs into ye Mediterranean, he conjectures that a great part of it may run out again, by an under-current, at ye Strait's mouth.

Wee then examin'd ye effects of a distillation of brine, from salt of Tartar, which Mr. Ballard at ye request of ye Company had performed; The brine was made of a pint of common water, and ℥iij of white salt, which, after sufficient heating, was distill'd from Salis Tart: ℥i: we saw about ½ lb. of ye distilled water; it was not in ye least brackish, but rather like an emulsion of sweet almonds.

1686. A Letter from Dr. Bagley to Mr. Musgrave was read: it gave an account of the dissection of ye *Hedghog*, male and female.

An account of a *horn* growing on the head of one Mary Davies of Soughal, of Wyrehall Hundred in Cheshire, aged 71. in 1668. The compasse of the horn at the root was 3 inches and more than half; the length of the horn layd out streight 5 inches and a half. An account of the Duke of Tuscany's *Diamond*, which weighs 138 carats. — An account given by Dr. Plot of *ale* made with *Wallnut leavs* instead of Hops in Staffordshire: there being great scarcity of these, last Summer; he says 'twas pleasant and kept very well.

The Society resolved that *Aristarchus* be printed in Greek and Latin at ye charge of this Society; Dr. Plot having promised to provide paper, and Mr. Deeds to collate the MSS.

A resolution of a question of compound *Interest*, at one operation of Logarithms, likewise a solution of this problem viz. from the different weights of the same heavie body in different fluids.

December 23, 1684. Mr. Musgrave acquainted ye Society concerning ye colour of ye liquor conveyed by ye Lacteals. In this letter he endeavors to prove, that a great part of ye Chyle passes *pellucid* through ye Lacteals, (contrary to ye opinion of those, who thought it to be *always white* in those vessells;) and that a pellucid Liquor Refluus does constantly fill *some* of them, when no flash of Chyle can be supposed to extend them. He then read Dr. Lister's answer to this Letter; The Dr. is willing to think that the *liquor Refluus* may be of ye nature of *Lympha* but he takes ye greatest part of what fills the Lacteals in sicklie and empty animals to be Pituita, and sometimes Bilis.

Mention was made of a proposall of Dr. Lister's, which was to try Kunckel's experiment [of coagulating milk, by adding spirit of wine to it,] both with a spirit, drawn from pure Nants-Brandy, and also with a spirit drawn from an eager wine: it being possible, as ye Doctor thinks, that ye experiment may succeed with ye one of them, and not with ye other.

Societies and Academies.

LONDON.

Faraday Society, November 16.—E. D. **Campbell**: A study of the correlation of the permanent magnetism and specific resistance of some pure iron-carbon alloys.—J. A. V. **Butler**: Co-ordination and co-valency. The formation of co-ordinated complexes cannot be due in general to the tendency of the central atom to attain the configuration of the next higher inert gas. The electrons contributed by co-ordinated groups form a distinct group round the central ion. A distinction is drawn between (*a*) *Co-valency*: the mutual sharing of electrons by two atoms so as to complete already existent groups, therefore involving negative valences, and (*b*) *Co-ordination*: the formation of a new group of electrons outside the last group represented in the ion. It is proposed to use the specific term *co-ordination valency* for the number of co-ordinated groups. It is assumed that the co-ordination electrons enter the main "quantum group" next to that represented in the central ion.—J. R. **Partington** and N. L. **Anfilogoff**: An improved form of electric vacuum furnace. A vacuum furnace of the Ruff type was used for studying reactions at high temperatures. The reacting substances, if solids, are contained in a graphite crucible turned from the same material as the hot tube and maintainable either in a high vacuum or in an atmosphere of an inert or reacting gas. The issuing gas is capable of analysis.—J. R. H. **Coutts** and E. M. **Crowther**: A source of error in the mechanical analysis of sediments by continuous weighing. The low density of suspension immediately below the balance pan after the sedimentation has proceeded for a few minutes inevitably sets up a flow of liquid which interferes with the free vertical fall of the particles. With the large narrow-rimmed pans hitherto used, the observed yields are appreciably below the theoretical values. With the pan close to the base there is a very rapid change of yield with very small changes in the position of the pan.—Donovan **Werner**: A simple method of obtaining the size distribution of particles in soils and precipitates. The method has been developed in researches on the reaction mechanism during the formation of precipitates. It has been necessary to know the total surface of a precipitate as a function of time while the precipitate is forming. At first the particles can be measured by an ocular micrometer, but just as the particles become larger and more irregular in size during the precipitating process, at the same time forming aggregates, it becomes correspondingly difficult to get values sufficiently exact. The measuring of the velocity of the sedimentation gives an "accumulation curve," and from this curve the size distribution can be calculated according to the mathematical theory developed by Odén.—F. G. **Tryhorn** and W. F. **Wyatt**: Adsorption by coco-nut charcoal from alcohol-benzene and acetone-benzene mixtures. Adsorption isotherms for each component of such mixtures have been determined at 20°. By an analogous method, measurements have been made of the composition of the vapours in equilibrium with mixtures of the above liquids at 20°. A comparison of the results of adsorption by charcoal from the liquid and the vapour phases supports the conclusion that an adsorbed film in equilibrium with a saturated vapour must be also in equilibrium with the liquid in contact with that vapour. Alcohol is selectively adsorbed from all mixtures of alcohol and benzene. From acetone-benzene mixtures, acetone is selectively adsorbed from mixtures containing up to 72 molar percentage

of acetone in the vapour phase. Above that value benzene is selectively adsorbed to a slight extent.—F. L. **Usher**: The nature of the interfacial layer between an aqueous and a non-aqueous phase. Experiments were undertaken to obtain information on the question whether the ions bearing a charge of opposite sign to that of the non-aqueous phase are movable only as a complete layer, or whether some or all of them are independent; and secondly, on the extent to which the observed behaviour of aqueous suspensions is in agreement with the consequences deduced from the answer to the former question. They deal (1) with the determination of the total charge on the particles of a suspension by neutralising it with a measured quantity of ions bearing a charge of opposite sign, and (2) with the effect of electrolytes in modifying the surface charge.

Geological Society, November 18.—W. L. F. **Nuttall**: A revision of the Orbitoides of Christmas Island (Indian Ocean). A complete revision has been made of Jones's and Chapman's species. Six species of Lepidocyclina, one species of Miogypsina, and one of Spiroclypeus were identified. The lepidocyclines possess no pillars in the lateral chamber-layer, and the two megalospheric forms have the embracing type of primordial chamber restricted to the subgenus Eulepidina. These species are found in Limestone C, as defined in the Christmas Island monograph (British Museum, 1900), which is classified as Lower Miocene. A Discocyclina has been found in Limestone B as well as in A, no orbitoides having been hitherto discovered in the former. This indicates that these beds are both of Eocene age.—W. Campbell **Smith**: The volcanic rocks of Christmas Island (Indian Ocean), with chemical analyses by E. D. **Mountain**. There were two periods of vulcanicity in Christmas Island. The older lavas are overlain by a limestone now proved by Mr. W. L. F. Nuttall to be Eocene. These upper lavas are overlain by a limestone with Orbitoides referred by Mr. Nuttall to the "older Miocene" of Rütten. All the lavas, both Eocene and Miocene, are considered to belong to a single petrological series. The rocks resemble very closely certain Tertiary and Permo-Carboniferous lavas from New South Wales. On the other hand, no analyses of rocks from Java and Sumatra are found to compare with those of the Christmas Island rocks.

Linnean Society, December 3.—F. J. **Lewis**: Preliminary account of a fungus in the tissues of Coniferæ. The results refer particularly to *Picea canadensis*, which has been collected from many habitats and varying in age from small seedlings to trees more than two hundred years old. The cortex of the youngest rootlets is penetrated in every direction by fine hyphæ, which not only enter the living cells, but grow through the middle lamellæ of the walls. They also penetrate the endodermal cells, and in some cases almost fill the lumen. Older rootlets from which the primary cortex has been cast off show the cells of the broad pericycle filled with fine branched hyphæ. In the unopened bud the fungus is localised in certain enlarged cells irregularly distributed above the crown near the base of the embryonic leaves. As the meristematic cone bearing the embryonic leaves elongates, the fungus spreads upwards from the region of the crown forming a network of infested cells.—Papers on the collections made during the expedition of H.M.S. *Sealark*.—Hugh **Scott**: The Ciidæ (Coleoptera) of the Seychelles. Ciidæ are small or minute beetles, usually of almost cylindrical shape, which are found boring in fungi, often in very large numbers. The present report enumerates 20 species, 18 of which were found in the Seychelles proper, while one was found both in the Seychelles and Aldabra, and one in Aldabra only. Taking the Seychelles species as a whole, more than half were found exclusively in the endemic forests at high elevations, and these insects are probably endemic; among the few species taken in cultivated places are the only forms (three in number) known to occur outside the islands.—D. J. **Matthews**: Physical oceanography of the Indian Ocean. A well-marked discontinuity layer occurs at nearly all the serial positions, and its presence appears to be independent of whether the station lies in the south equatorial current or not. At one position the current impinging on the bank north of the Farquhar Group at about 800 fathoms causes mixing at all depths, which lowers the temperature near the surface and increases it on the bottom by one degree Centigrade. The surface salinities are intimately connected with the currents and winds. The low salinity water which lies across the eastern entrance to the Gulf of Aden is present at all times, and is partly due to the current northwards along the east coast of Africa.—S. T. **Burfield** and E. J. W. **Harvey**: Four genera of Chætognatha were found. Of Sagitta, which contains 22 or 23 species generally considered valid, 14 species are represented. Of the 32 valid species of the phylum, 18 occur. The limitation of the number of species in the group is thus amply confirmed by this large collection.—C. J. **van der Horst**: The collections contain 18 species of the Eupsammidæ.—R. Douglas **Laurie**: Anomura from the West Indian Ocean. The Anomura were taken from localities between 3° and 21° S. Lat., and between 51° and 73° E. Long. They comprise 48 species distributed among the tribes Hippidea (1), Galatheidea (24), and Paguridea (23). The collection presents a typical Indo-Pacific facies. A fair proportion of the species are, however, now recorded for the first time from localities so far west in the Indo-Pacific Ocean. The three species of the present collection which reach the western coast of America, namely, *Petrolisthes lamarcki* (Leach), the deep-sea form *Parapagurus pilosimanus* Smith, and the land form *Cœnobita rugosus* H. M.-Edw., are three of the four which spread also to the Atlantic.—H. **Britten**: Coleoptera, Ptiliidæ of the Seychelles. The Ptiliidæ (or Trichopterygidæ) are the smallest of all beetles, and the various species found in the Seychelles range in length from 0·5 to 0·9 mm. Thirteen species are enumerated from these islands.

PARIS.

Academy of Sciences, November 9.—J. **Costantin**: An experiment with mountain-grown potatoes. It appeared probable that seed potatoes grown in the mountains and sown in the plains would be more proof against disease than ordinary potatoes. Some experiments made in 1925, although perhaps on too small a scale, confirmed this view.—Charles **Richet**, **Oxner**, and J. **Richard**: Raw meat and cooked meat diet for fish. Experiments showing that for fish as for mammals, cooking meat diminishes its nutritive value.—Léon **Guillet**: The influence of deformations on the transformations of certain light aluminium alloys. Study of the changes brought about in duralumin and in aluminium-copper-manganese alloy by wire drawing.— — **de Sparre**: Calculation of the maximum ram stroke in a pipe feeding a turbine with strong reaction for a constant velocity of closing.—Jean **Tilho**: The probable area of the maximum extension of the Aleatchadian sea.—J. **Schokalsky**: An oceanographic expedition to the Black Sea. Observations were made during 1924 and 1925 at 72 stations, the data obtained including depth, specimens taken on the sea floor, and determinations

of temperature, salinity, density, dissolved oxygen, sulphuretted hydrogen, hydrogen ion concentration, colour and transparency, as well as biological observations. The Black Sea can be considered as being divided into two layers, a superficial one of 200 metres containing water diluted by the inflow of numerous rivers, whilst from 200 metres to 2000 metres, the whole mass of water has a higher salinity and density than the upper portion.— — **Gunther**: A lemma of M. Poincaré.— — **Mandelbrojt**: Remark on the mode of generation of functional isogenes.— Const. **Parvulesco**: The dynamics of spiral nebulæ.— B. **Nikitine**: The distribution of the plankton of the Black Sea. The lower limit of appearance of the plankton is 200 to 225 metres. The principal influence on the vertical distribution of zooplankton is the temperature. In the case of the phytoplankton, besides the temperature there are the effects of variations in the quantities of inorganic nitrogen, phosphates, and silicates.—Paul **Pascal**: The magneto chemistry of closed chains. The experimental values for the molecular magnetic susceptibility for eight types of homocyclic and heterocyclic chains are compared with the figures calculated from the ordinary rules of additivity. In the polymethylene rings, the effect of non-saturation varies with the number of carbon atoms in the ring and is zero for the pentamethylene series. It is pointed out that the reductions in the molecular diamagnetism are in agreement with the predictions of Baeyer's strain theory.—E. **Jouguet**: Waves of shock and irreversible residual combustion.—J. **Cournot** and K. **Sasagawa**: The viscosity of some alloys at high temperatures.— H. **Perpérot**: The action of gaseous ammonia upon phosphorus chlorides. An attempt to prove that the primary action of ammonia upon the chloride PCl_n is $P(NH_2)_n$.—V. **Auger** and T. **Karantassis**: Complex salts of stannous iodide with the iodides of rubidium and cæsium. Preparation and analyses of the compounds $RbSnI_3$, $RbSn_2I_5$, $CsSnI_3$, and $CsSn_2I_5$.— B. **Bogitch**: The refining of mattes. The action of sodium sulphate.—A. **Mailhe**: A new method of bleaching petrols produced by cracking or by catalysis. Yellow petrols containing unsaturated hydrocarbons can be refined by digestion at the boiling point with stannous chloride.—Er. **Toporescu**: The cracking of ozokerite. Details of cracking experiments in which anhydrous aluminium chloride was used as a catalyst. —Albert **Kirrmann**: The action of metallic sodium on bromoethylene derivatives. The bromoethylenes R . CH : CHBr and R . CBr : CH_2 react with sodium giving the hydrocarbon R . CH : CH_2, the acetylene derivative R . C : CH, and small quantities of higher boiling point condensation products. The yields of the various types of hydrocarbon do not admit of a simple theoretical explanation.—A. **Demolon**: The clay material of the quaternary muds.—A. **Demay**: Two new forms of quartz in petrosiliceous porphyrys; lamellar quartz and spheroliths with granular quartz. —P. **Lejay**: Storm disturbances of the electric field and their propagation at a great distance.—Jean **Piveteau**: The signification of the sternum of the vertebrates. From three examples studied (Feylinia, Sphenodon, Tangasaurus) it is concluded that it is not possible to consider the sternum as a morphological entity, and that it can only be defined from a physiological point of view.—R. **Anthony**: A brain of the fœtus of *Megaptera boops*.—Raymond **Poisson**: Some observations on *Anisops producta*. The adult Anisops may prove to be a useful auxiliary in the battle against Anopheles.—Emile F. **Terroine**, R. **Bonnet**, and A. **Hée**: The energy yield in the development of various plant organisms as a function of the amount of oxygen in the surrounding medium.— Henri **Piéron**: Is the Bunsen-Roscoe law applicable to the luminous stimulation of the invertebrates? Experiments made on the effect of light on Mya (movement of retraction of the siphons) proved that the Bunsen-Roscoe law does not hold.—Robert **Lévy**: The hæmolytic properties of the pedicellular processes of certain urchins.—Mme. Anna **Drzewina** and Georges **Bohn**: The acidification of the medium by cellular cytosis.

ROME.

Royal Academy of the Lincei, Communications received during the vacation, 1925.—F. **Zambonini** and R. G. **Levi**: Investigations on the isomorphism of the molybdates of the rare earth metals with those of calcium, strontium, barium, and lead.—Mineo **Chini**: Determination of the isogonal trajectories of a system of lines in certain surfaces.—Bruno **Finzi**: Considerations on the irrational motions of liquid laminæ.—E. **Raimondi**: Dynamic effect of a current flowing between a plate and an indefinite plane wall. —U. **Crudeli**: Method of resolving a fundamental problem in the theory of the stationary slow motion of viscous liquids. — Rita **Brunetti**: Continuous absorption along an optical series and the structure of the discontinuity of absorption at high frequency. —V. **Ronchi**: Measurement of double stars with a grating interferometer.—G. **Bargellini**: α-Phenyl-β-methylcoumarins. Descriptions are given of a series of products obtained by condensing various ortho-hydroxy-substituted acetophenones with sodium phenylacetate and acetic anhydride.—Remo de **Fazi**: Syntheses in organic chemistry by means of radiant energy. (i.) Photosynthesis of αββ-triphenyllactic acid. This acid is formed by the addition of a molecule of benzophenone to one of phenylacetic acid under the influence of light.—G. **Scagliarini** and E. **Brasi**: Additive compounds of tin and titanium halides with organic bases.—G. **Checchia-Rispoli**: Vertical diffusion of *Orbitoides s. str.* — Tullio **Carpanese**: The epidote of Monte Rosso di Verra (Monte Rosa group).—A. **Clementi**: The osmotic pressure of the hæmo-lymph and tissues of *Helix A.* during lethargy. — Giuseppe **Russo**: The curve of development of a xylophagous coleoptera, *Chætopelius vestitus*.

VIENNA.

Academy of Sciences, October 22. — Papers on electrolytic conductivity in molten metal alloys. —XI. R. **Kremann**, H. **Krieghammer** and P. G. **Rehenburg**: Na-Hg alloys of various composition. —XII. R. **Kremann**, H. **Krieghammer** and A. **Trostek**: Bismuth-tin alloys. — XIII. R. **Kremann** and O. **Baukovac**: Tin-cadmium alloys. — XIV. R. **Kremann** and J. **Dellacher**: Attempts at electrolysis of alloys of aluminium with magnesium, antimony, zinc and silver.—XV. R. **Kremann** and O. **Baukovac**: Attempted electrolysis of metallic sulphides and of phosphides.—XVI. R. **Kremann** and K. **Bayer**: Electrolysis of alloys of silver with Sn, Sb, Bi and Pb.—E. **Steinach**, H. **Heinlein** and B. P. **Wiesner**: Release of the sexual cycle, development of sex characters, rejuvenating effect on the senile organism of extracts of ovary and placenta. Experiments on rats and guinea-pigs. In the last two years experiments have been carried out with extracts of gonads and other organs, and in testing the effect of these extracts the criteria chosen have been the development of sexual characteristics in animals castrated in infancy, the rejuvenating effect on senile females and also the release of the sexual cycle. A stable substance has been obtained from the ovary and from the placenta which on injection produces these effects.— A. **Smekal**: On the constitution of the mono-crystalline state of aggregation. The ideal crystal lattice

differs greatly in its properties from those of the actual single crystal. It is assumed that real crystals have numerous pores and zones of disturbance. Complexes of some thousands of molecules seem to form higher units in crystallised bodies. (See also a lecture at the Danzig Physics Congress.)

Official Publications Received.

Forest Bulletin No. 66 (Economy Series): A Note on the Working Qualities of some Common Indian Timbers. By H. E. Kinns. Pp. iv +43. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1s.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, Nos. 2, 3, 4: Investigations on Indian Opium, Nos. 4, 5, 6. No. 2: Further Experiments on the Influence of Manures on the Yield and Morphine Content of the Latex from the Opium Poppy, by Dr. Harold E. Annett and Har Dayal Singh; No. 3: Experiments on Oil-Content of the Seed of the Opium Poppy; and No. 4: Studies on the Ash Constituents of Indian Opium, by Dr. Harold E. Annett and M. N. Bose. Pp. 25-51. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10*d*.

Commonwealth of Australia: Bureau of Meteorology, Melbourne. Bulletin No. 16: Australian Hurricanes and related Storms, with an Appendix on Hurricanes in the South Pacific. Prepared by Dr. Stephen S. Visher and D. Hodge. Pp. 54+3 charts. (Melbourne: H. J. Green.)

Government of India: Department of Industries and Labour, Public Works Branch. Triennial Review of Irrigation in India, 1921-1924. Pp. ii+43. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s. 9*d*.

Glass Research Association. Bulletin No. 14, August: A Review of the Work of the Association, 1920-1925. Pp. 106. (London: Wilfrid C. Smith, Liquidator, 48 Copthall Avenue.)

Department of the Interior: North West Territories and Yukon Branch. Canada's Arctic Islands: Log of Canadian Expedition 1922. By J. D. Craig; with an Appendix, Aviation in the Arctic, by Major R. A. Logan. Pp. 27. Canada's Wild Buffalo: Observations in the Wood Buffalo Park. By Maxwell Graham; with an Appendix, A Reconnaissance in the Home of the Wood Buffalo, by F. W. Seibert. Pp. 17+2 maps. Local Conditions in the Mackenzie District 1922. By J. T. Moran. Pp. 19+1 map. (Ottawa: F. A. Acland.)

Tide Tables for the Pacific Coast of Canada for the Year 1926: including Fuca Strait, the Strait of Georgia, and the Northern Coast; with Data for Slack Water in the Navigable Passes and Narrows and Information on Currents. (Twenty-sixth Year of Issue.) Pp. 72. (Ottawa: F. A. Acland.) Free.

Tide Tables for the Eastern Coasts of Canada for the Year 1926: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. (Thirtieth Year of Issue.) Pp. 76. (Ottawa: F. A. Acland.) Free.

Report on Norwegian Fishery and Marine Investigations. Vol. 3, No. 5: Merking av Sei i Nordland sommeren 1921 beretning avgit til Fiskeridirektøren. (Summary in English.) Av Oscar Sund. Pp. 24+3 plates. (Bergen: A.S. John Greigs Boktrykkeri.)

Queensland Department of Mines: Queensland Geological Survey. Publication No. 275: Index to Publications No. 267 to 274 (Vol. 8 of New Series). By Miss M. G. Wood. Pp. 39. (Brisbane: Anthony James Cumming.)

Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. 3, No. 6: Nasal Granuloma in Cattle. By Prof. V. Krishnamurti Ayyar. Pp. 159-166+9 plates. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 1 rupee; 1s. 6*d*.

Department of Agriculture, Straits Settlements and Federated Malay States. Bulletin No. 37: The "Mouldy Rot" Disease of Hevea Brasiliensis in Malaya. By F. W. South and A. Sharples. Pp. ii+31+4 plates. (Kuala Lumpur.) 50 cents.

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 9, Nos. 1, 2 and 3. No. 1: A Contribution towards a Monograph of the Indian Coniopterygidæ (Neuroptera), by Dr. C. L. Withycombe; No. 2: Papers on Indian Tabanidæ—viii: The Bionomics and Life-Histories of some of the Common Tabanidæ of Pusa; and No. 3: Some Observations on the Life-History and Habits of Phycus brunneus, Wied. (Family Therevidæ), by P. V. Isaac. Pp. 30+11 plates. 2.2 rupees; 4s. Chemical Series, Vol. 8, No. 1: The Quality and Yield of Tobacco as influenced by Manurial and other Operations. By J. N. Mukerji. Pp. 26. 8 annas; 9*d*. (Calcutta: Government of India Central Publication Branch.)

Ceylon Administration Reports for 1924. Department of Agriculture: Report of the Director of Agriculture for 1924. Pp. D52. (Colombo.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear New Series, No. 24, July. Pp. 194. (London.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 77: Fishes from Natal, Zululand and Portuguese East Africa. By Henry W. Fowler. Pp. 187-268. (Philadelphia.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 313: Terrestrial Magnetism—The Earth's Magnetism. By Daniel L. Hazard. (Special Publication No. 117.) Pp. 52+6 plates. (Washington: Government Printing Office.) 15 cents.

The Brooklyn Institute of Arts and Sciences. Brooklyn Museum Science Bulletin, Vol. 3, No. 3: Revision of the New World Species of the Tribe Donaciini of the Coleopterous family Chrysomelidae. By Charles Schaeffer. Pp. 45-165. 1 dollar. Vol. 3, No. 4: Notes on certain Books of Unusual Interest in the Blackford Collection of the Brooklyn Museum. By E. W. Gudger. Pp. 167-172. (Brooklyn, N.Y.)

The Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions, and for the Attainment of Economy in the Application of Steam. Memorandum by Chief Engineer for the Year 1924. Pp. 52. (Manchester.)

Boletin de la Sociedad Geológica del Perú. Tomo Primero. Pp. vi+126+31 lamina. (Lima.)

The Government of the Philippine Islands: Department of Agriculture and Natural Resources, Bureau of Science. The Mineral Resources of the Philippine Islands for the Years 1921, 1922 and 1923. Issued by the Division of Geology and Mines, Bureau of Science. Pp. 63. (Manila: Bureau of Printing.)

Canada. Department of Mines: Geological Survey. Memoir 146, No. 126 Geological Series: Retreat of the Last Ice-Sheet in Eastern Canada. By Ernst Antevs. Pp. iv+138+9 plates. (Ottawa: F. A. Acland.) 25 cents.

Proceedings of the Liverpool Geological Society. Session the Sixty-sixth, 1924–25. Part 2, Vol. 14. Edited by C. B. Travis. Pp. xvii+99-195+plates 5-9. (Liverpool.) 5*s*.

Department of the Interior: U.S. Geological Survey. Mineral Resources of the United States in 1924 (Summary Report). Introduction by Frank J. Katz; Statistics assembled by Martha B. Clark. Pp. ii+108A. (Washington: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 529: Surface Water Supply of the United States, 1921. Part 9: Colorado River Basin. Pp. v+181+2 plates. 25 cents. Bulletin 766: Spirit Leveling in California, 1896–1923. Pp. ii+748. 80 cents. Bulletin 781A: Paleozoic Formations penetrated by Wells in Tishomingo County, North-eastern Mississippi. By M. N. Bramlette; with Notes on Paleozoic Rocks encountered in a Well near Florence, Alabama, by H. D. Miser. Pp. 12+1 plate. (Washington: Government Printing Office.)

List of Memoirs, Maps, Sections, etc., published by the Geological Survey of Great Britain and the Museum of Practical Geology to 30th June 1925. Pp. 115+5 plates. (London: H.M. Stationery Office; Southampton: Ordnance Survey Office.) 1s. net.

Development Commission. Fifteenth Report of the Development Commissioners for the Year ended the 31st March 1925. Pp. vi+198. (London: H.M. Stationery Office.) 2s. 6*d*. net.

Memoirs of the Geological Survey of India. Vol. 50, Part 1: Descriptions of Mollusca from the Post-Eocene Tertiary Formation of North-Western India; Cephalopoda, Opisthobranchiata, Siphonostomata. By the late E. Vredenburg. Pp. xii+350+xvi+13 plates. (Calcutta: Government of India Central Publication Branch.) 5.6 rupees; 8s. 9*d*.

Forest Bulletin No. 65 (Silviculture Series): Tables for Bark Deductions from Logs. By S. H. Howard. Pp. ii+11. 3 annas; 4*d*. Forest Bulletin No. 64 (Economy Series): Summary of Results of Laboratory Experiments with different Wood Preserving Antiseptics (Results of 14 Years' Experiments). By S. Kamesam. Pp. ii+28+5 plates. 1.12 rupees; 3s. (Calcutta: Government of India Central Publication Branch.)

Diary of Societies.

FRIDAY, DECEMBER 18.

SOCIETY OF MEDICAL OFFICERS OF HEALTH (at the Medical Institute, Newcastle-upon-Tyne), at 5.—Prof. H. Kerr: Industrial Hygiene from the point of view of Public Health Administration.—Sir T. Oliver: Industrial Hygiene from the point of view of the Physician.—G. France: Industrial Hygiene from the point of view of the Works Director.—Capt. J. Robinson: Industrial Hygiene from the point of view of the Welfare Supervisor.

INSTITUTE OF TRANSPORT (North-Western Local Section) (at the Midland Hotel, Manchester), at 6.30.—E. G. Garstang: Transport in Connexion with the Fishing Industry.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at 36 George Street), at 7.—Prof. E. Knecht: The Effect of Mercerising on the Liability to Attack, by Oxidation, of Cotton Fabrics, and The Estimation of Glucose and other Carbohydrates by an "Absolute" Method.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at the Technical College, Swansea), at 7.15.—E. E. Ayling: Modern Resistance Glasses.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section) (at the Grosvenor Restaurant, Glasgow), at 7.15.—J. Marsden: Unshrinking Wool.

AERONAUTICAL ENGINEERS (at Royal Society of Arts), at 7.30.

INSTITUTION OF MECHANICAL ENGINEERS (Yorkshire Branch) (at the Philosophical Hall, Leeds), at 7.30.—Prof. G. F. Charnock: The Importance of Close Speed Regulation in Driving Machinery.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. R. E. Roberts and Dr. M. J. Cohen: Paget's Disease of Bone.—Dr. P. J. Briggs: Methods of Examination of the Pelvic Cæcum.

SATURDAY, DECEMBER 19.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.—J. S. Carson: A System of Mechanical Coal-mining combined with the Adoption of Systematic Timbering, using Composite Steel Props.—Dr. J. N. Williamson and Prof. H. Briggs: Experiments on Fan Casings and Fan Inlets.

MONDAY, DECEMBER 21.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Sir J. J. Thomson: The Intermittence of Electric Force.—Prof. A. R. Forsyth: A Chapter in the Calculus of Variations: Maxima and Minima for Weak Variations, of Integrals involving Ordinary Derivations of the Second Order (*To be read by title*).—Dr. A. C. Aitken: On the Theory of Graduation (*To be read by title*).—Prof. C. E. Weatherburn: On Triple Systems of Surfaces and Non-Orthogonal Curvilinear Co-ordinates (*To be read by title*).

TUESDAY, DECEMBER 22

INSTITUTE OF MARINE ENGINEERS, at 6.30.—C. Hughes: Fuel Injection.