THURSDAY, MARCH 27, 1919.

TRANSLATED SENSE AND SENSES.

Human Physiology. Vol. iv. "The Sense-organs." By Prof. L. Luciani. Translated by F. A. Welby. Pp. x+519. (London: Macmillan and Co., Ltd., 1917.) Price 21*s.* net.

A MAN'S name linked to a star seems certain of long-continued remembrance, joined to a rose not quite so certain. Somewhere between these extremes of permanent fame and evanescent esteem is the fate of a name associated as advisedly with a part of the central nervous system as is Luciani's with that of the cerebellum. No one can speak of Luciani's cerebellum, since that would be unforgivably personal, but it is quite impossible to talk of the cerebellum without referring at once to Luciani. It is important to remember this when dealing with Luciani's statements about the function of almost any part of the body, certainly of the nervous system. It is very important to have it in mind when considering the value of his opinions on various psycho-physical phenomena, as in the concluding chapter of this volume.

Now what has been said might be considered a sly rebuke of egotism, but that is not in the least true. There is nothing in the book but the very comprehensive range of truth examined painstakingly by its author, and no egotism whatever. The point is this, that you cannot make an intimate acquaintance with the cerebellum, an organ which has apparently no part whatever to play in displays of consciousness, without being impressed with the value of nervous factors not directly concerned in displays of consciousness, but yet obviously controlling in some degree the factors responsible for such displays. Progress towards a veneration for "subconscious" nervous factors is inevitable, and if it is not checked there is a yielding of rigid definitions sufficient to allow of some debate about "unconscious sensations and feelings." The temptation may soon become invincible to say that "these nervous processes . . . fulfil the same functions as conscious sensory processes; it follows that they come into the range of mental life, and even constitute by far the largest part of the integral content of the mind" (p. 440).

Now there is no formal connection between this passage and the cerebellum. It is merely Luciani's statement as to certain general processes associated with other parts of the nervous system, but there is wisdom, in the writer's opinion, in remembering, when reading it, that the cerebellum has apparently no direct link with consciousness, and that Luciani has probed the part it plays. He has shown that it acts as an intermediary in maintaining and modifying that distributed "tone" of the skeletal musculature which is the essence of posture and a necessary basis for the strength and precision of movement, even of *voluntary* movement. It is clear that the translation from "tone" to "voluntary movement" is through much the same scale as from "subconscious" to "conscious" feeling.

Perhaps it may be difficult to discover what all this has to do with the subject in hand, the fourth volume of Luciani's "Human Physiology," but not, I think, when the book is read, and it is well worth reading. The original work is well known as a comprehensive, scholarly, and interesting text-book. It has now, in large part, been translated into English, and edited in an able fashion for the use of English readers. In this anglicised form it is already widely appreciated, and it will be agreed that the "tone" of the original, which might, indeed, have been gravely depressed in the process, has been well maintained. The cerebellum of the book, nowhere represented in consciousness, but everywhere evident in the characteristics of attitude, is as it was. That is to say, as a whole; but there are here and there parts where—well, perhaps any critical reader of the dioptrics of the eyeball in this fourth volume will find reasons for expressing criticism. That part of the matter is exceptional in being not quite so good as the remainder.

This fourth volume on the sense-organs should prove widely useful not only to students of physiology and medicine, but also to students of psychology. As a clear and pregnant expression of knowledge of these sense-organs to be found in a volume unburdened by the inclusion of other parts of physiology, there is at present nothing so good, perhaps not even the corresponding fourth volume of Foster, which will remain for long, like Ecclesiastes, as a penetrating and abiding lesson in judgment—better than this, but which did not contain quite so much physiology.

It is true that, in the writer's opinion, the book is otherwise burdened by the concluding discussion on psycho-physical phenomena, but that is a matter which may be criticised better by students of psychology, by whom it may also be seen as the heel of Achilles, or perhaps surprisingly as a very head-piece. It is true also that there are various decisions which would not have been reached by other competent authors. It may or may not be the case that muscular sense has a content which is nothing more or less than common sensibility, and that the tectorial membrane is the primary resonator apparatus of the cochlea. There are many such conclusions, which might be discussed, and may need revision. It may be the case that there are complete neurones in the immediate vicinity of taste-buds; it is not the case that observers have found the radius of curvature of the anterior surface of the crystalline lens to be between 2·9 and 4·0 mm. (p. 287); but what of it? There may be misjudgment, there are some errors, but there are everywhere knowledge, tone, and interest.

The volume was well worth translating, and has been translated and edited very well. Here and there a statement issues as it would never come from a writer of English; here and there a slip in the translation of a technical term has escaped the editor; but generally the combined efforts of translator and editor have been most successful. As in the other volumes, the newly appended references will prove of considerable value. J. S. MACDONALD.

SOUTH AFRICAN GRASSLANDS.

The Grasses and Grasslands of South Africa. By Prof. J. W. Bews. Pp. vi+161. (Pietermaritzburg: P. Davis and Sons, Ltd., 1918.) Price 7*s.* 6*d.* net.

THIS little volume is a contribution to the study of South African plant ecology, a subject on which Prof. Bews has already published several papers. In studying the plant succession in the grasslands of South Africa, it was found necessary to devise a simpler means of identifying the species than that afforded by the key to the genera given by Dr. Stapf in his elaborate account of the grasses in the "Flora Capensis." An artificial key was therefore drawn up, and has been included in the present volume. The test of such a key is its value to the working field botanist, and Prof. Bews states that it has met with the approval of his fellow-workers. Following the key are a number of ecological notes on the principal species in each genus, the genera being arranged in alphabetical order. These notes embody many of the author's observations, his object being to set forth the principal facts that have been ascertained regarding the part played by the more important species in the grassland plant succession, and also by means of selected examples to illustrate the general differences which are shown in morphological characters, and particularly in leaf-anatomy.

The study of a simple transverse section of the leaf of a grass may give more information as to its nutritive value than an elaborate chemical analysis of the herbage, for the latter will vary greatly according to the time of year, and even according to the state of the weather. Xerophytic grasses, in which the leaves have to protect themselves against excessive transpiration, grow less quickly, and are not so valuable for pasturage as the more mesophytic types. A notable exception to this rule is *Danthonia purpurea,* Haas grass, or hare grass. Although in general appearance this is a xerophytic plant, farmers are agreed that it is also a very nutritious species. It is low-growing, being rarely more than an inch or two in height, with deep roots and numerous densely leafy shoots, and is peculiarly adapted to growing over the surface of hard-baked clay soils. It has become completely dominant in the grass veld for miles around Molteno, in the Stormberg region, near the eastern edge of the Karroo.

The ecological notes are illustrated by somewhat diagrammatic cross-sections of the leaves of the more important species, which indicate especially the distribution of the hard, mechanical tissue. The author then gives a general sketch of the grasslands of South Africa and their development. Five main regions are considered—namely, the south-western or Cape region, the western region, the sand veld region, the Karroo and Karroid central region, and the eastern grass veld region. The boundaries of these regions are shown in a map which forms the frontispiece. Finally, a short section is devoted to some economic questions concerned with grass-burning, stock-grazing, the feeding value of natural grasses, the cultivation of grasses, and soil erosion. An appendix gives in tabular form a list of English, Dutch, Zulu, and Sesuto names. A striking feature is the large number of names in the Zulu indicating a remarkable discrimination of species.

COLLOQUIAL CHEMISTRY.

Everyman's Chemistry. The Chemist's Point of View and his Recent Work told for the Layman. By Ellwood Hendrick. Pp. x+319. (London: University of London Press, Ltd., 1918.) Price 8*s.* 6*d.* net.

MR. HENDRICK has written an extremely original book. To use his own words: "The whole thing is a sporting proposition between you, the reader, and me. If I can hold your attention until you have read it through, I shall have succeeded in my intention." It is only fair to say that, if the reader possesses ordinary intelligence, he will be able to pick up a good deal of interesting information from the book, even if he comes away from it with confused ideas as to how chemists attain their results.

The style is colloquial in the extreme, and no one need be deterred from beginning the book by any fear of high-and-dry treatment, whilst the professional chemist will derive a good deal of amusement from the manner in which facts are presented. A few of Mr. Hendrick's headings will make clear what is meant: "Polygamy in Chemistry"; "Nitrogen, its Satanic Tricks"; "The Old Horse of Chemistry"; "The Ironmaster's Torment and Why he Swears"; "The Chemical Old Mare"; "The Grand Old Tramp who Left his Mark"; "The Red-headed Halogens."

It would be a mistake to suppose, however, that Mr. Hendrick has not done a useful piece of work in writing the book. He has kept in view the fact that the man in the street is not particularly interested in theory, but prefers to learn something about practice; and it is safe to say that few popular books contain such a mass of examples of the application of chemistry to practical problems. No one who reads this work can fail to appreciate the manner in which chemistry has permeated the whole of modern society. The uses of sulphuric acid, described on pp. 86–88, should awaken the layman to the fact that, from the time he turns on the tap of his bath in the morning until he finishes his breakfast, he is continually coming in contact with materials the production of which is possible only owing to the employment of sulphuric acid. And when prose fails him Mr. Hendrick is by no means averse to calling in the aid of rhyme.

On the purely theoretical side Mr. Hendrick's treatment of the subject is scarcely so satisfactory. It is very doubtful if a beginner would be much wiser about the ionic theory after reading pp. 22–25; and the description of the origin of stereochemistry on pp. 244–45 scarcely does van't Hoff justice, whilst Le Bel is not even mentioned in that connection.

At the present time, when it seems necessary that the general public should appreciate what chemistry does for them, even if they cannot understand how it does it, Mr. Hendrick's book should play a very useful part; and it is to be hoped that the demand for it among laymen will be a large one. Admitting the limitation which the author imposed upon himself, there can be no doubt that the book is excellent.

OUR BOOKSHELF.

Hygiene of the Eye. By Dr. W. Campbell Posey. Pp. x + 344. (Philadelphia and London: J. B. Lippincott Co., 1918.) Price 18*s.* net.

IT is a good sign that ever greater attention is being directed to preventive medicine, for prevention is better than cure. The proverb is specially apposite when applied to many disorders of the visual apparatus. A sound treatise on the hygiene of the eye is badly wanted—or, rather, it should be said, two such works are to be desired, one for ophthalmologists, and one for the general public. Dr. Posey's work fails to meet either requirement satisfactorily, for it falls between two stools. The chapters on the structure of the eye and on diseases of the eye are too elementary for the ophthalmologist, and scarcely intelligible to the layman. Moreover, the considerable space allotted to many diseases of which we do not know the causes, or are unable to prevent them, might have been better utilised in expanding parts more nearly related to what is commonly understood by the term "hygiene." The chapter—by the author—on school life is particularly good, and the same may be said of the chapters on artificial illumination (by Dr. Herbert E. Ives) and on daylight illumination (by Mr. W. C. Farber, an architect). These subjects would have borne further elaboration.

The author's chapters on conjunctivitis and the preventive measures to be adopted against contagion, and on wounds and injuries of the eye, are admirable. The chief industrial injuries are described, and the means of protection against them are illustrated by good photographs. There is a most interesting chapter on blindness from an economic and social point of view, and on the education and employment of the blind, by Mr. O. H. Burritt, principal of the Pennsylvania Institution for the Instruction of the Blind.

Dr. Posey is a safe guide, though he makes some dogmatic statements with which all ophthalmologists would not agree. We hope that a second edition will give him the opportunity of eliminating irrelevant material and expanding those parts which are more in accord with the title.

Elements of General Science. By Prof. Otis William Caldwell and Prof. William Lewis Eikenberry. Revised edition. Pp. xii + 404. (London: Ginn and Co., 1918.) Price 5*s.* 6*d.* net.

THOSE who are interested in the teaching of natural science are already familiar with the publications of Messrs. Ginn and Co. in connection with the elementary and general treatment of the subject. The "Elements of General Science," by Profs. Caldwell and Eikenberry, rapidly found favour in England among the many who were growing dissatisfied with the dry and formal teaching which has been all too common. The authors succeeded in being simple without being superficial, and, with the help of the publishers, in producing a book which can be read with pleasure as well as with profit—a point which is so often overlooked.

The revised edition, which has been largely rewritten, is much bigger than the original one. Electricity and magnetism have now been included. In the forty-eight pages devoted to these subjects there are to be found figures of lighting-circuits, watt-hour meters, motor-car circuits, telephones, and transformers. Another thirty-five pages have been given to astronomy, with a series of excellent figures. The problems of nutrition and of food have received additional attention, and it is entirely in keeping with the spirit in which the book is written that five excellent charts have been prepared showing the relative costs of equivalent food-values of different things. In this, as in many other ways, the relations between the studies and the problems of everyday life have been kept prominently in view. The teacher who uses this book is not likely to be bothered by the question, "What is the use of learning this?" And yet the authors cannot be accused of having neglected true education in the effort to interest or amuse.

The Year-book of the Scientific and Learned Societies of Great Britain and Ireland. Compiled from Official Sources. Pp. viii + 333. (London: Charles Griffin and Co., Ltd., 1918.) Price 9*s.* net.

THE present is the thirty-fifth annual issue of this very useful work of reference. Twenty-six societies not previously included appear in this edition, and the claims of music to be numbered among the learned societies have been recognised. The compilation constitutes a record of the work done in science, literature, and art during the session 1917–18 by the various societies and Government institutions, and deserves an important place among the reference books of workers in science. The arrangement and method of indexing adopted make reference to the contents easy.

LETTERS TO THE EDITOR.

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

Globular Clusters, Cepheid Variables, and Radiation.

DR. SHAPLEY makes the suggestion (NATURE, March 13) that known supplies of energy become adequate to maintain stellar and solar radiation through astronomical time if we can suppose that radiation is propagated only from matter to matter, and is not radiated equally in all directions. In brief, we see the sun because the sun has in some way first seen us. Prof. Soddy points out (NATURE, March 20) that we have no direct evidence of loss of radiation into space; "experiment and observation justify only the conclusion that radiation is propagated between portions of space occupied by matter, . . . elsewhere it may not be propagated at all." Prof. Soddy is, perhaps, on safe ground as regards laboratory experiments, but it seems to me that astronomical evidence is against him.

We see star clusters by light which has journeyed for 200,000 years to meet us; by what mechanism could this light calculate 200,000 years ago that to-day we should be where we are? There seem to be only two possibilities open: the cones of light projected from matter to matter may be more than big enough to catch the matter aimed at, or light may not travel in straight lines, adjusting its course as it proceeds on its voyage through space.

Under the first possibility the whole advantage of Dr. Shapley's hypothesis disappears. We see, say, 10^9 stars, so that, presumably, 10^9 stars see our sun. Suppose our sun sends out 10^9 cones of light each big enough to be fairly sure of catching a star. Stellar velocities being of the order of 10^{-4} times that of light, each cone must be of angle about 10^{-4} radians, and 10^9 such cones just about fill up the solid angle of space. The hypothesis has lost its only advantage.

Suppose, as an alternative, that the presence of a star in some way guides the light from another star towards it. The path of a ray of light is no longer a straight line, but a sort of "curve of pursuit." To catch the light from a star we ought no longer to point our telescopes $20{\cdot}4'' \times \sin\lambda$ forward along the earth's path in space, but an equal amount backwards. The aberration-correction becomes reversed, and all determinations of parallax, proper motions, etc., become illusory. One puzzle might be solved, but at the cost of shattering almost the whole fabric of astronomy.

Thus if Dr. Shapley's very strong case for a long time-scale is accepted as proved, I think we must look for a new mechanism of production of energy; the problem is not solved by a mere rearrangement of the expenditure. In looking for possible new sources of energy, we ought to remember that our knowledge of physics is derived wholly from experiments conducted at the surface of a planet with the aid of light emitted from the surfaces of sun and stars. Our whole knowledge of physics is "surface-physics"; it is the special physics of conditions in which radiation is free to scatter into space, so that radiation pressure is negligible. There may be a more general physics applicable inside a star, and this may contain sources of energy unknown to us. There is, for instance, a possibility I suggested in 1905, which Dr. Shapley considers "bizarre." Conservation of mass and of energy may be only phenomena of "surface-physics." Inside a star, matter and energy may be interchangeable. The intrinsic energy of an electron being mC^2, the transformation of 1 per cent. of the sun's mass into energy would yield up radiation enough for 150,000,000,000 years.

J. H. JEANS.

March 22.

THE suggestion of Dr. Harlow Shapley and Prof. Soddy that radiation only occurs between portions of space occupied by matter is difficult to reconcile with the very considerable cooling by radiation that takes place on a cloudless night, when, on the supposition in question, it should be almost negligible—less, indeed, than with an overcast sky.

Such a law of radiation would have other strange results equally inconsistent with experience.

JOHN W. EVANS.

Imperial College of Science and Technology, South Kensington, March 21.

Scientific Research at St. Andrews University.

THE president of the Edinburgh Royal Society in his address alluded to in NATURE of March 13 has done full justice to the St. Andrews University, Chemical Research Department, which owes its prosperity to the munificence and the example of my late colleague, Prof. Purdie, and also to his relatives. It likewise throughout has had the unvarying support of the University Court, which allocated a large sum (more than 5000*l.*) from the Carnegie Trust Grant to the University for its maintenance.

But there is an older research department in the University of St. Andrews which has been overlooked by Dr. Horne, viz. that for research in marine zoology and the fisheries at the Gatty Marine Laboratory, the oldest marine laboratory in Britain, and the scientific work emanating from which will speak for itself. Its trained workers hold, and have held, important posts in the three centres of the kingdom and in the various Colonies, as well as in foreign countries. That it should have been severed from connection with the Government by the Secretary for Scotland in 1896 (after twelve and a half years' labour), when the new building was erected on University ground, seems a paradox when the heavy expenditure (which still goes on) in subsidising the International Fisheries Council is remembered.

Chemistry research, adequately endowed, can be carried out anywhere, whereas work in marine zoology and the fisheries can nowhere be more successfully pursued than in the bay and on the shores of St. Andrews, where Prof. John Reid, the distinguished physiologist, first dealt with its riches. There the pulse of the North Sea is daily felt, and every student of Nature is beckoned to engage in the elucidation of the endless variety of its fauna and flora. It is to be hoped that the University Court, which has closed the laboratory at present from motives of economy, will soon reopen it.

W. C. MCINTOSH.

Maceration by Tryptic Digestion.

WITH reference to the paragraph on the method of maceration by tryptic digestion in NATURE of March 6, p. 9, it may be of interest to your readers to learn that further work on the process has shown that equally good results are obtained by the use of Messrs. Allen and Hanbury's *Liquor Trypsini Co.* This costs only 3*s.* 9*d.* a bottle, and the requisite strength is obtained by adding 1 c.c. to a litre of water. The procedure is in other respects identical with that previously described. The trouble of dissolving the powder is thus avoided, and the cost is reduced from 1*s.* per litre to rather less than ½*d.*, so that the method becomes practicable for use on a large scale.

On the whole, the optimum temperature is a high one, about 55° C., and this has the additional advantage of somewhat reducing the unpleasant smell.

KATHLEEN F. LANDER.

Zoological Society of London, Regent's Park, N.W.8, March 19.

Glass) × Optical glass

OPTICAL GLASS.

ONE of the surprises of the great war has been the revelation to the majority of people of the extent to which a nation may be absolutely dependent for the conduct of the war on an industry which, in its magnitude, may seem quite insignificant, but, owing to the technical experience underlying it, cannot be acquired in a short space of time. In the forefront of such vital industries is the manufacture of optical glass. However great the other resources in men and material may be, it would be quite impossible to wage successful warfare without adequate supplies of optical glass for binocular field-glasses, range-finders, artillery sights, photographic lenses for aircraft, etc. It is of interest to trace briefly the history and practice of this important "key" industry, and to consider how the nation will be situated as regards the supply of optical glass when peace is restored and it will again be in competition with German glass.

The manufacture of homogeneous glass suitable for optical instruments dates practically from the time when the achromatisation of lenses became possible. Up to that time selected pieces of sheet glass served for the manufacture of the crude optical appliances then in use. Switzerland was originally the home of the optical glass industry, when, at the beginning of last century, its manufacture was undertaken by Guinand, who discovered how to make glass homogeneous by stirring. For a short time the production of optical glass was carried on by Fraunhofer at Munich, and, about the middle of last century, Messrs. Chance Brothers, of Birmingham, with the assistance of M. Bontemps, who had worked in France with Guinand's eldest son, commenced the manufacture of this material. Methods of manufacture have not materially changed since that date, but more uniform results are now obtained, in what was formerly a very hazardous process, by the use of gas furnaces, careful temperature control, and attention to detail in every direction.

Optical glass is made by melting the necessary ingredients at a very high temperature in clay crucibles or pots. When the mass has fused to a clear liquid free from bubbles, the molten glass is stirred for a long time by a thick fireclay rod. The viscosity of the liquid makes perfect admixture by eddy currents and diffusion a slow process, and all the time the glass is exerting a corrosive action on the sides of the pot and stirrer, and the products of this action tend to contaminate the glass and produce striæ.

When it is deemed desirable to discontinue the stirring process, the pot is allowed to cool. When cold, the glass in the pot is found to be much fractured, and falls to pieces when the pot is "broken down." The fragments of glass are heated until they soften, and then reduced to suitable shape by moulding. After being ground and polished, the lumps are examined for striæ, and perhaps one-quarter of the mass may be found to be of good optical quality. When optical glass is required in the form of discs or prism blocks, selected plates are brought to the required form by a second moulding process.

The discs, etc., must then be annealed, or very slowly cooled, so that the stresses which would be set up in the glass by rapid cooling may be reduced to a minimum and have no harmful effect on the performance of the optical component into which it is fashioned by the optician.

FIG. 1.—A stage in the manufacture of optical glass. On the right-hand side is a pot or crucible in which glass has been founded which has been allowed to cool and is now ready to be broken down. On the left hand will be seen a pot of glass which has been partially broken down.

The production of good yields of high-quality glass, even of the oldest crown and flint types, is an operation which requires skill and long experience. Apart from this, the present very varied requirements of opticians necessitate the production of varieties of glass which are widely different in composition, and the manufacture of glasses having the optical constants requisite to meet the needs of the lens computer calls for expert scientific assistance.

During the first half of last century the requirements of opticians were fairly satisfied by a limited range of glasses. Scientific work on the production of new types was carried out in this country for many years by Harcourt and Stokes, but, though admirable in its scope, this work had a somewhat limited end in view—namely, the reduction of secondary spectrum—and met with no considerable success.

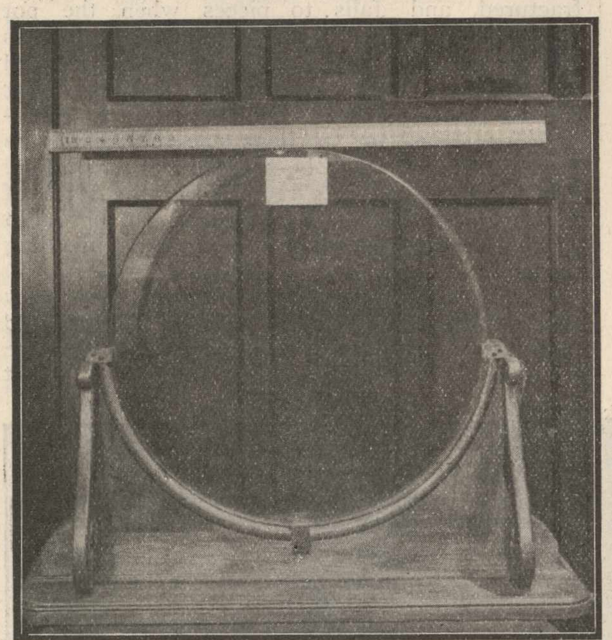

FIG. 2.—Disc of crown glass, 28 in. in diameter, made by Messrs. Chance Brothers just before the war.

The English firm and that of Mantois, of Paris, held the field up to about 1880. About this time, owing to the happy collaboration between the very distinguished optician, Abbe, and the able chemist, Schott, extensive research on the subject of new optical glasses was carried out in Germany.

The advent of dry-plate photography and the special corrections desirable in camera lenses, as well as in microscopic objectives, gave a great stimulus to the work of these investigators, and their researches, carried out with more perfect technical appliances, had a wider aim in view than those of the English experimenters. The results obtained were of such promise and importance that Government assistance was forthcoming in the setting up of works for the manufacture of new glasses on a commercial scale, and the painstaking efforts of these men of science in overcoming the difficulties involved were eventually rewarded with well-deserved success.

As a result, opticians were compelled for many years to go to Germany for glasses having special properties such as were absolutely necessary for them in the design of the better types of certain optical instruments. And, as many of the more important instruments during the latter part of last century were of German design, the firms concerned naturally transferred almost the whole of their orders from the English and French firms to Schott and Co., of Jena, and, in fact, so far as the military requirements of Germany were concerned, they were compelled to do so by the German Government.

It may be said, however, that the products of the English and French firms, as regards the older varieties of optical glass, were never surpassed by the Jena firm. This is evidenced by the fact that the English and French firms produced the great majority of the large discs for the giant astronomical refracting telescopes constructed during the last forty years. At the British Scientific Products Exhibition recently held in London and Manchester, a fine disc of crown glass, 28 in. in diameter, which was produced immediately before the war, was exhibited by Messrs. Chance Brothers.

The British firm, in particular, was slow in taking up the manufacture of the newer types of optical glass, and had to encounter serious disadvantages in coming late into the field in this

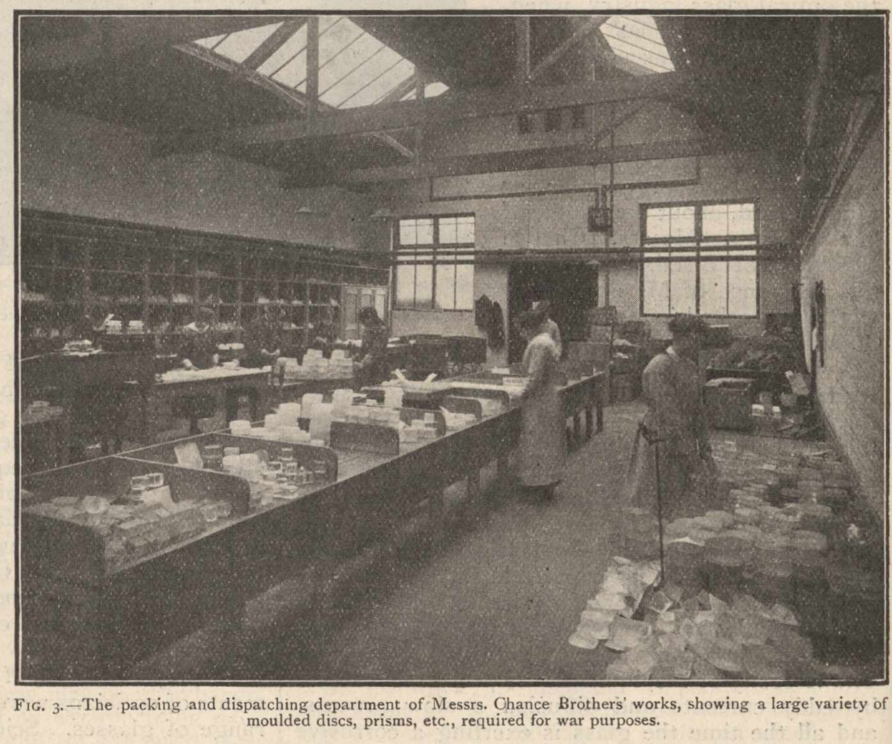

FIG. 3.—The packing and dispatching department of Messrs. Chance Brothers' works, showing a large variety of moulded discs, prisms, etc., required for war purposes.

respect, as also in being unable to obtain any Government assistance. The great value of the previous production of optical glass in this country, however, was felt at once on the outbreak of war, when Messrs. Chance Brothers were able to extend their resources, and, without outside assistance of any kind, to develop the manufacture of all the types of glass required by opticians, including some of the most extreme of the Jena varieties, which became necessary owing to an extended programme of work undertaken in connection with photographic lenses for aircraft.

In 1916 it was thought desirable (partly as a precaution against the results of possible aerial attack) that, for the manufacture of this important material, the nation should not be dependent on a single source of supply, and the Derby Crown Glass Works, Ltd., were encouraged to commence its manufacture, and they have already been successful in producing a number of types of optical glass of good quality. Still more recently the United States, though, to a large extent, dependent on English and French resources for optical glass for war purposes, have commenced its manufacture on their own account, and have already achieved some success in this direction.

Such are the demands of war on the optical industry that towards the end of hostilities one British firm was producing twice as much optical glass as the world's total output previous to the war. In considering, further, the position of the industry after the war, it is therefore obvious that there are resources in this country for the manufacture of all the optical glass which will be required by our opticians. Nor need there be any apprehension regarding the ranges of glass which will be available for the use of the lens designer. Without any notable exception, Messrs. Chance Brothers have been able, by their previous experience and by the work of their research laboratory, established during the war, to produce glasses which, in their optical constants, cover the full range of glasses mentioned in the Jena list for 1913.

The further development of the optical glass industry would appear to be well provided for in view of the practical research work carried out by the manufacturer and of the more general work conducted by the British Scientific Instrument Research Association, recently formed under the direction of the British Optical Instrument Manufacturers' Association. To maintain the supremacy of the nation in regard to this manufacture, however, it is not only necessary to be able to produce the material of good quality, but it is further essential that it should be produced at prices which will compete with those of foreign firms. With the greater time which manufacturers will be able to devote to the subject with this end in view, there should be no difficulty in arriving at a satisfactory solution of this point.

However large the possible output and however perfect the quality of British optical glass, the future of the industry can be assured only if British opticians are able to achieve and maintain supremacy in home and foreign markets by excellence in the design and workmanship of their instruments of precision and by cheapness of manufacture of the more common optical products. Fortunately, there has been full appreciation of this aspect of the situation, and in the Imperial College of Science and Technology there is now a Technical Optics Department, under the direction of Prof. F. J. Cheshire, and with the courses of lectures given there, including those by so able a computer as Prof. A. E. Conrady, the department should greatly assist in ensuring that this country is well supplied with expert designers of optical systems. The wide increase in membership of the Optical Society and the valuable papers contributed thereto by workers in the National Physical Laboratory and in the research departments of academic institutions and firms are also of happy augury for the future.

Before the war, computers designed lenses to utilise existing Jena glasses of definite optical constants. It would be undesirable and unfair to British manufacturers to reverse this process completely. Computers should be prepared to do a certain amount of recalculation, and so avoid imposing on the manufacturers the wasteful task of producing a glass to imitate exactly the hazard constants obtained in the particular foreign melting used previous to the war.

SULPHURIC ACID AFTER THE WAR.

THE Departmental Committee on the Post-war Position of the Sulphuric Acid and Fertiliser Trades, which presented a report, with certain omissions and modifications deemed necessary in the national interest, in February of last year (Cd. 8994), has now issued an amended and complete edition (Cmd. 23) in substitution for that paper.

The changes are not numerous, although important for the consideration of the matters with which the Committee was concerned. They relate principally to the pre-war production of sulphuric acid; to an enumeration of the principal consuming trades and their estimated annual consumption prior to 1914; to the sulphuric acid trade during the war, showing its enormous expansion; to certain statistical facts connected with the development of the zinc industry during the war, and its influence on the acid situation; to the probable post-war consumption of sulphuric acid; and, lastly, to a list of acid factories owned or leased by the Government, with their situation and output.

Although certain of the matters now dealt with were probably known more or less accurately to German manufacturers who had pre-war business relations with this country, or kept themselves informed of its trade developments, it was obviously undesirable that many of the facts brought to the knowledge of the Committee should be published whilst we were actually at war. Sulphuric acid is all-important as a prime material in the manufacture of munitions, and it need scarcely be said that the enemy would have welcomed official information as to how far this country was able to meet the sudden and unexpected demand on her resources occasioned by a struggle of such magnitude as that in which she was involved. The Germans began the war in the confident belief that the resources of all their enemies would be either quickly exhausted, or incapable of full utilisation before the lightning-stroke they contemplated should have determined the issue. They will learn the extent of their miscalculation, at least as regards sulphuric acid in this country, should they care to study the figures which the Committee now makes known.

The actual consumption of sulphuric acid in Great Britain before the war is not known with certainty, as no detailed statistics are available, but the Committee has been at pains to collect information from authorities, and gives the following table showing approximate estimates of the annual pre-war consumption by the more important trades :—

	Tons 100 per cent. acid per annum	Tons equivalent chamber acid
Superphosphates ...	300,000	450,000
Sulphate of ammonia ...	280,000	420,000
Bleaching powder, hydrochloric acid, alkali, and alum	186,000	279,000
Iron pickling	70,000	105,000
Recovery of grease ...	20,000	30,000
Copper sulphate ...	25,000	37,000
Dyeing and bleaching ...	25,000	37,000
Dyes	Very small	—
Oil refining	20,000	30,000
Explosives	30,000	45,000

"Iron pickling" refers to the use of the acid in the tinplate and galvanising trades, and "recovery of grease" to its employment in connection with the treatment of wool-washing liquors, etc., in the textile trades. These figures, although admittedly only approximate, are valuable as showing the relative distribution of the main amount of sulphuric acid produced in this country. It will probably be news to many people that considerably more than half is needed for the manufacture of fertilisers.

In addition to the trades mentioned, sulphuric acid is used in a number of minor industries, but no exact estimate can be formed of the aggregate amount. The Committee is probably within the mark in assuming that the annual production in the British Isles before the war was about 1,000,000 tons of 100 per cent. acid, or 1,500,000 tons of chamber acid. It considers that this quantity may also be taken as the national consumption, since both the export and import of sulphuric acid were negligible in amount.

Sulphuric acid goes into industry of several degrees of strength, by far the largest amount being used in the form of "chamber acid"—that is, as produced directly in the lead-chambers, and without subsequent concentration. The concentrated acid of 95 per cent. strength was produced to the extent of 75,000 tons. What is known as "contact acid" or oleum amounted to about 22,000 tons per annum. It is used mainly in the manufacture of explosives and dyes, and was produced only by three firms.

No estimate of the actual amount of sulphuric acid employed for munitions since 1914 is furnished by the Committee, but some idea of its magnitude may be gained from certain figures adduced by them to show the post-war position of the industry after allowing for a reversion to normal working conditions.

	Pre-war (Tons 100 per cent. acid per annum)	Post-war (Tons 100 per cent. acid per annum)
Oleum	22,000	450,000
Chamber	1,040,000	1,265,000
	1,062,000	1,715,000
Equivalent chamber acid	1,593,000	2,572,000

It will be seen that the amount of "oleum"—the variety of special importance in the manufacture of munitions—increased more than twentyfold in the course of the war, and mainly during the last two or three years of it. But a considerable amount of concentrated chamber acid was also gained by restricting supplies to manufacturers of superphosphates and to certain other trades. Large oleum plants were erected by the Government in connection with its explosive factories, and the productive capacity of the plant either owned or leased by the Ministry of Munitions is estimated by the Committee at 315,000 tons 100 per cent. acid, equivalent to 472,000 tons chamber acid, per annum, or rather less than half the gross estimated surplus.

In its previous report the Committee considered what steps might be taken to safeguard the sulphuric acid industry after the war in view of the position created by it. Not only has a large amount of new and valuable plant been erected —more than peace conditions can utilise—but a further extension of the industry is imminent, owing to the prospective development of zinc production in this country, and the consequent necessity for dealing with the sulphurous acid produced in roasting the concentrates. Some time before the war Herr Hasenclever, a well-known German chemical manufacturer, in the Hurter lecture to one of the sections of the Society of Chemical Industry, pointed out what had been the result on the price of sulphuric acid of the action of the German Government in compelling the zinc manufacturers of Silesia to condense their acid fumes —an admitted necessity. It is quite evident from the tenor of its report that the Committee is apprehensive of a similar result here. There is likely to be a glut of sulphuric acid and a serious depreciation of prices for some time to come unless plant is scrapped or shut down. The most obvious remedy is a great extension of the fertiliser industry, but this is not immediately possible, unless there is a more rapid development of the by-product coking industry, and a consequent increase in the production of ammonia, and larger available supplies of mineral phosphates. The Committee, of course, recognises this fact, and in its present report it makes this additional recommendation: "That the Government should take immediate steps by international commercial treaties or otherwise to secure an effective and permanent control or command of an adequate supply of phosphate rock, and that arrangements should be made in advance for the importation of large quantities of phosphate rock immediately on the termination of the war."

There is more in this recommendation than meets the eye. Certain of the forfeited Colonial possessions of the Germans contain valuable deposits of phosphate rock, and others are known which ought to be, and doubtless would be, exploited if a demand were created. It is to be hoped that the Government may be in a position to act promptly upon this recommendation, and thus enable at least some portion of the large and valuable plant created by the war to be utilised before it is too late, for the benefit of chemical industry and the welfare of agriculture.

NOTES.

THE Marconi Wireless Telegraph Co. is to be congratulated on having established experimental wireless telephonic communication between Clifden, Co. Galway, in Ireland, and Cape Grace, in Canada. This is not surprising after the company's feat last year of establishing wireless communication between England and Australia—a distance of 12,000 miles. The improvements which have been made in thermionic valves—for instance, the reduction of the air-pressure in the valve to the one-hundred-millionth of a millimetre of mercury—have increased their sensitivity enormously. In addition, by connecting them "in cascade" there appears also to be no limit to the sensitivity that can be attained. The Australian results were obtained by using three small Marconi Q-type valves in cascade. Wireless telephonic transmission is specially interesting, as it is free from many of the defects of ordinary telephony, in which sound distortion presents serious difficulties over long cables. There seems no reason to doubt that in a short time wireless telephony will be established between every country on the globe. The necessity for well-thought-out international laws to regulate this traffic is therefore pressing.

VISCOUNT HARCOURT deserves the thanks of all interested in the restitution of our museums for his persistent worrying of the Government and for his letter to the *Times* of March 22. In answer to his question on March 19 he was informed that the London Museum would be restored to the public in a few weeks. "Temporary buildings are to be erected in the suburbs for the staffs now in occupation" of the Imperial Institute and the Tate Gallery, "but the new accommodation cannot be available for at least six months." The Education Department, it is expected, will soon return to Whitehall. There is, however, "no immediate prospect" of vacating the National Portrait Gallery, Hertford House, or the remaining galleries of the National Gallery and the British Museum. As regards the last institution, an article in the *Times* of March 21 did well to remind the public that the greater part of the old building is now accessible. The situation, no doubt, is difficult, as Sir Alfred Mond has explained in a long statement to the Press, but the agitation has succeeded in speeding up the Government, and once more we may exclaim, "Thank God, there is a House of Lords!"

THE absence of recognisable meteorites from the series of stratified rocks is a notable fact, possibly due to the disintegration of the meteoric substance, which even in our museums displays a deplorable tendency to decay. The British Museum has, however, recently acquired among slices and fragments of various recent falls or finds a slice weighing 362·5 grams of the meteoric iron which was found in January, 1905, on Claim No. 7, Skookum Gulch, 9½ miles S.E. of Dawson, Klondike. This, as well as another meteoric iron found in 1901 on Gay Gulch, in the same neighbourhood, was lying deep down in the so-called "white-channel gravels," which are the oldest high-level gravels of the district, and are believed by Mr. R. G. McConnell to be of Pliocene age or older. The original specimens are in the Museum of the Geological Survey at Ottawa, where they have been examined by Mr. R. A. A. Johnston (1915), who infers from their similar structure and composition that they formed part "of a single meteoric shower which took place back in Tertiary time."

AN address on "Acute Pneumonic Tuberculosis" will be delivered by Sir W. Osler before the Tuberculosis Society at 8.30 p.m. on Monday, April 28.

NEWS has reached us of the death on March 8, at thirty-seven years of age, of M. Jacques Danne, editor of the well-known French journal *Le Radium*.

WE learn with regret from Tuesday's *Times* that Sir E. C. Stirling, F.R.S., professor of physiology in the University of Adelaide, and director of the South Australian Museum, died on March 20 at seventy years of age.

NEXT Thursday, April 3, Prof. A. Findlay will deliver the first of a course of two lectures at the Royal Institution on colloidal matter and its properties. The Friday discourse on April 11 will be delivered by Sir J. J. Thomson on piezo-electricity and its applications.

THE Paris correspondent of the *Times* announces the death on March 19, at seventy-seven years of age, of Prof. F. H. Hallopeau, member of the Paris Academy of Medicine, and author of a treatise on general pathology and numerous papers on therapeutics and dermatology.

THE death is announced, in his seventy-sixth year, of Prof. Charles L. Doolittle, who was professor of astronomy at Lehigh University from 1875 to 1895, and at the University of Pennsylvania from 1895 to 1912. Prof. Doolittle was treasurer of the Astronomical Society of America from 1899 to 1912, and was the author of notable papers on the variation of latitude, the constant of aberration, and related subjects.

THE Regional Association will hold its next conference at Malvern on April 9–16. The object of the conference is to study the Malvern region from the physical, historical, and social points of view and to facilitate the interchange of ideas of all who are interested in the study of their environment. A series of lectures and excursions has been arranged. The local secretary is Mr. E. W. Harris, The High School, Malvern. The first annual report of the association, a copy of which has been sent us from the office, 11 Tavistock Square, W.C.1, shows that a considerable amount of work has been done in the past year in spite of difficult circumstances. In many parts of the country the intensive survey of regions has been undertaken. It is hoped that some of these surveys will soon be ready for publication in view of their important bearing on local schemes of social betterment and reconstruction.

THE annual general meeting of the Ray Society was held in the rooms of the Geological Society on March 13, the president, Prof. W. C. McIntosh, in the chair. Resolutions of regret at the death of Dr. F. Du Cane Godman, treasurer for fourteen years, and of Canon A. M. Norman, a former member of the council, were passed. The treasurer, Dr. S. F. Harmer, was congratulated upon his appointment as director of the Natural History Museum. It was announced in the report of the council that vol. iv. of the "British Fresh-water Rhizopoda and Heliozoa," by G. H. Wailes, was ready for binding, and that the "British Orthoptera," by W. J. Lucas, and vol. i. of the "British Charophyta," by James Groves and Canon Bullock-Webster, were in the press. Prof. E. B. Poulton was elected a vice-president, and Dr. A. W. Alcock, Dr. G. B. Longstaff, and Mr. A. W. Oke were elected new members of the council. Prof. McIntosh, Dr. Harmer, and Mr. John Hopkinson were re-elected to their respective offices of president, treasurer, and secretary.

ON March 18 the Illuminating Engineering Society held its tenth anniversary dinner, the president, Mr. A. P. Trotter, presiding. The toast of the society was proposed by Mr. Thos. Goulden, senior vice-president of the Institution of Gas Engineers, and seconded by Mr. C. H. Wordingham, president of the Institution of Electrical Engineers, both of whom referred to the valuable, impartial platform which the society affords for the discussion of topics of common interest to both gas and electrical engineers. In replying to the toast, the president remarked that the society's activities have expanded continuously since its foundation, and it has frequently brought together those interested respectively in the design and manufacture of lighting apparatus and those who use it. Mr. F. W. Goodenough proposed the toast of kindred societies, represented at the meeting by the Royal Society, the Royal Society of Arts, the British Science Guild, the Council of British Ophthalmologists, the Royal Institute of British Architects, the Institutions of Gas, Electrical, and County and Municipal Engineers, and the Electrical Contractors' Association, on behalf of which Sir George Beilby, Col. J. Herbert Parsons, and Mr. A. A. Campbell Swinton replied. Mr. Gaster, in proposing the toast of "The Guests," referred especially to the important report issued by the Home Office Departmental Committee on Lighting in Factories and Workshops in 1915, and expressed the hope that in the near future there will be definite legislative reference to the provision of adequate lighting in factories in the interests of health, safety, and efficiency of work. In the United States such legislation has been adopted by five of the States, and it is to be hoped that this country, which took the initiative in this matter before the war, will regain the lead.

IN an article entitled "International Use of Patent Searches," published in the Journal of the Patent Office Society for February last, Mr. Scott H. Tilly directs attention to a wish expressed in an address given by the director of the Canadian Patent Office to the employees of the United States Patent Office to the effect that the Canadian Patent Office might officially have the benefit of searches made in the United States in respect of any matter in relation to which applications are also filed in Canada. It is argued that, since the great majority of applications filed in Canada are filed in substantially the same form in the United States of America, one search as to novelty should be sufficient; and further, since the facilities for search are better in the United States than in the Dominion, the single search suggested should, in the interests of economy and efficiency, be conducted at Washington. Mr. Tilly desires to see the matter carried further still, and suggests that it is worthy of investigation whether it could not be made profitable for Washington to report as to novelty, not only to Canada, but also to England and to the other British Colonies having patent systems. However, as it is the standard of novelty accepted in any particular country, and not the form in which applications are filed there, that determines the value of the examiner's work, no useful purpose would be gained by the adoption of the proposals for instituting a single search. The legal standard of novelty accepted in this country has, from the inventor's point of view, many advantages over the standard adopted in the United States; therefore, by resorting to the protection of the British patent law inventors in our Colonies stand to gain. Further, in cases where the Colonies are unable to provide for efficient search for their own purposes, the proper remedy seems to be for the Imperial Government to make suitable arrangements for conducting patent searches in London on behalf of those Colonial Patent Offices which may desire to avail themselves of the exceptional facilities existing in this country for such a purpose.

DR. W. H. RIVERS has reprinted from the Bulletin of the John Rylands Library (vol. iv., 1918) a lecture entitled "Dreams and Primitive Culture." He discusses the most essential feature of Freud's theory, according to which "the dream as we remember it, and record or relate it—the manifest content of the dream—is the product of a process of transformation. By means of this process the motives producing the dream—the latent content of the dream, or the dream-thoughts—often find expression in a form differing profoundly from that by which they would be expressed in the usage of ordinary waking life." The next process, that of symbolisation, "implies a relation between the underlying motive of the dream and the form in which this motive is expressed, the relation being of such a kind that the image of the manifest dream is a concrete symbol of the thought, emotion, or sentiment which forms its latent motive." On this analogy, among savage peoples, dramatic representation goes far more deeply into the texture of their lives than would appear if we attend only to its place in religious ritual. This would go some way to explain why rude rites and customs have their origin in the unconscious, and it enables us to understand why it is impossible, among peoples of the lower culture, to obtain any rational explanation of rites and customs, even when such explanation seems to us to be obvious.

IN a recent issue of the *Rivista di Antropologia* Prof. Giuffrida-Ruggeri makes a contribution ("Se i popoli del mare delle iscrizioni geroglifiche appartengano tutti all' Italia") to the much-discussed problem of the identity of the Mediterranean peoples who took part in the conflicts with Egypt during the Nineteenth and Twentieth Dynasties. He agrees with A. J. Reinach as to the history of the Etruscans. As Seneca wrote, *Tuscos Asia sibi vindicat*. At the time of the great Mediterranean turmoil (thirteenth and twelfth centuries B.C.) the "Tursha" or Etruscans were among the people who set out from their Lydian home and attacked Egypt. "They came to the Nile Delta with their women and children, and were evidently looking for land to colonise, but were 'thrown into the sea' (*circa* 1260 B.C.) by the armies of Merenptah, and again by Ramses III. (*circa* 1190 B.C.). These failures must have diverted them in another direction, towards the barbaric regions of the west. So it was that about the eleventh century B.C. their boats reached the western peninsula, the fabled Hesperia, and they occupied Tuscany." But Prof. Giuffrida-Ruggeri disagrees with Reinach's claim that their Lydian neighbours, the Shardana, occupied Sardinia at the same time. His reason is that Sardinia was "a very difficult country to occupy, strongly fortified, and inhabited by a fierce population." The Sardinians were a Mediterranean people who "provided war material for the confederation of the 'peoples of the sea' who attacked Egypt. They took part in this attack with valour, such as their descendants have recently shown in the battles of the Isonzo."

IN *Science* (vol. xlviii., No. 1250, December 13, 1918) Mr. S. O. Most discusses the problems, methods, and results of the study of behaviour. He thinks that from time to time it is advantageous to trace the course of scientific development and adjust plans for the future. He gives a historical review of the study of behaviour from the unscientific acceptance of the soul as the controlling agent of all activities—the current view of pre-Renaissance times—through the seventeenth-century belief in the purely mechanical action of men and animals—a belief which inspired much research—to the nineteenth-century realisation of the complex nature of the problem. The problem is a practical one, as is evidenced by the work of such societies as that of the anti-vivisectionists, who, though often inconsistent, yet base their activities on an assumption of the likeness between animals and man with regard to pain. The author urges the claims of a comparative study of behaviour in spite of its anthropomorphic tendencies. He thinks that the differences between the mechanists and vitalists are mainly verbal, the one believing that all reactions are completely determined by material configurations, the latter that the reactions are not thus completely determined, the differences, though, lying in an ambiguous use of mechanical reduction. Whichever view is held, the scientific worker is in equal degree bound to ascertain by experimental methods every possible sequence of phenomena ending in reactions. Hitherto all attempts to reduce animate responses to physico-chemical principle have resulted in evidence which shows that a great majority of such responses are, in a measure, mechanically determined. To ascertain the extent of this determination is an important problem both for the vitalistically and the mechanistically inclined men of science.

IN the February issue of *Reveille* (No. 3) "Economist" discusses "the cost of consumption." The author points out that in ten years the deaths from tuberculosis in England and Wales are not far short of the total deaths in the British and Dominion forces during the war. He pleads for the extension of colony treatment, such as obtains at Papworth, where the consumptive, after a period of observation in a sanatorium, is allowed by slow degrees to begin working, preferably at his old occupation, or, if that is unsuitable, at some new occupation which does not require too long a period of training. After a few months, when ready to leave the sanatorium, and if a suitable case, the patient is encouraged to settle on, or in the neighbourhood of, the colony. This means subsidised labour, a costly matter, but probably no more costly than allowing the patient to die, while the ultimate gain by the reduced risk of infection is very great.

A PAPER by Harriette Chick, E. Margaret Hume, Ruth F. Skelton, and Alice Henderson Smith on the prevention of scurvy (*Lancet*, November 30, 1918) is of some botanical as well as medical interest. "Lime-juice" has a well-known reputation as an anti-scorbutic, dating from the eighteenth century, and there is every reason to believe that it was, in fact, the use of "lime-juice" which was responsible for the disappearance of scurvy from the British Navy in the early part of the nineteenth century. Towards the end of that period, however, various Arctic explorers became sceptical about its value, and it has been subjected to much adverse criticism as a prophylactic or therapeutic agent in the late war. The authors found in animal experiments that the current lime-juice is of very little value, but that lemon-juice is effective in preventing scurvy in guinea-pigs. The historical researches of Mrs. Henderson Smith cleared up the puzzle. The original "lime-juice" came from the Mediterranean, and was derived partly from the sweet lime (*Citrus medica* var. *limetta*), but chiefly from the lemon (*C. medica* var. *limonum*); it was what we should now call "lemon-juice." About 1865 the cultivation of the sour lime (*C. medica* var. *acida*) had become a considerable business in the West Indies, and the Admiralty patriotically transferred its contracts from Malta and Sicily to English firms; they got what we now call "lime-juice," and it was useless. In the same series of nutritional investigations made at the Lister Institute, Harriette Chick and Mabel Rhodes (*Lancet*, December 7, 1918) direct attention to the fact that the most potent anti-scorbutics are all crucifers—cabbage, "scurvy grass" (Cochlearia), and "cresses" of various kinds; swedes are much more efficient than carrots (Umbelliferæ) or beetroots (Chenopodiaceæ).

THE efforts made to introduce the use of bracken rhizomes as food for stock do not receive much encouragement from the results of experiments with pigs and poultry reported in Bulletin No. 89 of the West of Scotland Agricultural College. In the experiments with pigs an increased live-weight was certainly secured by the use of the bracken rhizomes, but this represented only a very meagre return. In the case of poultry the results as indicated by egg-production were entirely disappointing. In both cases the experiments were admittedly not on a sufficient scale to warrant definite conclusions, but the outlook for the promotion of bracken to the dignity of a fodder crop does not appear hopeful.

MR. G. T. MOORE (Annals of the Missouri Botanical Garden, vol. v., No. 3, 2 plates, 1918) gives an account of a new wood-penetrating alga, *Gomontia lignicola*, found on a yellow-pine board in a fresh-water pond near Woods Hole, Massachusetts, the study of which has cleared up several points in the life-history of the genus. The plant consists of unbranched cylindrical filaments in which a striking appearance is produced by the concentration of most of the chlorophyll in the terminal cell, the remaining cells being so devoid of colour as to have the appearance of a fungal hypha. The plant is reproduced by zoospores, which are formed in large numbers in sporangia of extremely irregular outline, and either germinate directly to produce a new filament or form resting-spores. The latter are very irregular in size and shape, brilliantly green and full of starch, and may rest for months, or even years, before germination.

ONE of the most destructive of recent Italian earthquakes, of which little was heard at the time, occurred in the Upper Tiber valley on April 26, 1917, at 9.40 a.m. (G.M.T.). Though the area of damage, according to Prof. Oddone (*Boll. Soc. Sis. Ital.*, vol. xxi., 1918, pp. 9–27), contains only about seventy-five square miles, there was within it a small district in which the intensity of the shock surpassed the highest degree (10) of the Mercalli scale, the destruction of houses being as complete as at Messina in 1908 and Avezzano in 1915. The epicentre of this earthquake is in 43° 28·2′ N. lat., 12° 7·7′ E. long., and it is evident that the focus was at a slight depth. Among the after-shocks was one of less, but still ruinous, intensity, which occurred on April 27 at 2.30 p.m. (G.M.T.).

MR. R. M. DEELEY has sent us a copy of a paper contributed by him to the *Philosophical Magazine* for March, 1918, in which he discusses the temperature distribution in a cyclonic depression, and puts forward a hypothesis as to the causation of these depressions. Upper-air research by means of sounding balloons has shown that in the troposphere the core of a cyclone is cold relatively to the surrounding air, whereas at greater heights, in the stratosphere, the reverse is the case, the air being relatively warm. It is suggested that this warmth probably extends to the confines of the atmosphere. The author considers that the air which flows spirally inwards in the lower layers rises in the central region of the cyclone to great heights, flowing outwards in the higher levels of the stratosphere. This circulation being postulated, it remains to find some means by which the column of rising air in the stratosphere may be warmed, and this Mr. Deeley ascribes to the action of a pencil of high-velocity cosmic matter which strikes and heats the outer part of the atmosphere in a localised patch. The heating is regarded as being produced rapidly and as dying away slowly. According to this theory, cyclones must travel with the winds of the upper atmosphere, which carry the heated core with them. No attempt is made to explain how a cyclone can persist for days, or even weeks, as it travels over the surface of the earth.

AT a meeting of the Institution of Civil Engineers on March 12 three papers were read on electric welding developments. There are three systems in general use. In "spot" welding the metals to be soldered together are placed in contact and an electric current sent between them. This method is rapid and efficient, and is easily performed by unskilled labour. In "seam" or "line" welding, mechanically driven roller electrodes are used; and in the "carbon-arc" process the metal is melted by means of the electric arc. It was pointed out that electric welding would be particularly helpful in the automobile industry, as crank-shafts, broken or worn teeth of gear-wheels, and gear-cases can rapidly be renovated. In shipbuilding it was stated that electric-arc welding has proved successful for forging, riveting, and caulking. It has been found possible to join thick steel plates by welding more economically than by riveting. Experiments showed that in the case of butt-welds the tensile strength of the joints was from 90 to 95 per cent. of that of the solid plate. In the "carbon-arc" process the carbon rod formerly used has now been replaced by an iron welding pencil, which is found to be far more suitable.

THE March issue of the *Geographical Journal* contains a paper by Mr. E. A. Reeves, the map curator of the Royal Geographical Society, on "A Transformation of the Magnetic Dip Chart." The transformation carried out by Mr. Reeves consists in drawing lines through those places on the earth's surface at which the axis of the dip-needle makes equal angles with the axis of the earth instead of with the horizontal plane through the place of observation. This plan gives more regular lines, which approximate to circles having an axis inclined at 3° to 5° to that of the earth. In a contribution to the discussion on the paper Dr. Chapman pointed out that whatever axis were taken as that from which to measure the inclination of the dip-needle, the curves of equal inclination would approximate to circles about an axis between that chosen and the magnetic axis, so long as the earth approximated to a uniformly magnetised sphere. Dr. Chree also pointed out how closely the earth corresponds with a sphere uniformly magnetised about an axis inclined at 12° to the geographic axis. The paper and discussion point to the desirability of taking as the axis of reference the magnetic rather than the geographic axis of the earth.

"EXPERIMENTS with Clay in its Relation to Piles" was the subject of a paper by Mr. A. S. E. Ackermann read before the Society of Engineers on March 10. The experiments described deal on a small scale with the resistance of clay to penetration by discs, pyramids, and cylinders. In one test a cylinder of clay 2 cm. in diameter and 68 cm. in length, fixed at one end and twisted at the other through $37\frac{1}{2}°$, recovered when released through 32°, which is taken to be a proof of the elasticity of clay. The resistance to penetration (without shock) increases as the water-content diminishes. If $W+w$ is the resistance to penetration and V the volume of penetration, then for pyramids $V=a(W+w)^n$, where n is about 1·5. In the case of discs at critical loads the disc started and continued to sink in the clay, the pressure, taken to be the pressure of fluidity, being on the average 587 grams/cm.^{2}, the water-content being 29 per cent. The general conclusions are:—(1) For tapered bodies the load for a given penetration is proportional to the area of surface of contact; (2) it is much greater the less the percentage of water in the clay; (3) the pressure of fluidity is less when the percentage of water is greater; (4) tapered piles support a greater load than parallel-sided piles; and (5) pointed piles are more efficient than blunt. In the application of these results to practice it must be remembered (apart from the small scale of the tests) that the clay with which an engineer deals is less homogeneous than the puddled clay employed; that piles are driven by impact, which disturbs the earth round the pile; and that the important point is not the resistance when driving, but after a period when the earth is more or less resettled. The tests are, however, interesting to physicists and engineers.

A SUGGESTION was made a few days ago during a sitting of the Coal Commission that if higher wages were to be paid to miners, manufacturers would be driven to America or Sweden to seek the advantages of water-power. The allusion to Sweden is striking testimony to the rapid developments which are now taking place in the hydro-electric installations of that country. *Engineering* has from time to time published particulars of these enterprises (reference has also been made to them in these columns), and in its issue of March 7 it has a long article dealing with the impending extension of hydro-electric power schemes under the auspices of the Royal Swedish Waterfalls Board. A power station is projected in Lapland with a capacity of 192,500 kw., having its source in the chain of lakes, the lowest of which, Storea Lulea, finds an outlet in the River Lule. The river is about 100 miles in length, and debouches into the Gulf of Bothnia, just below the Arctic Circle. Two important falls on the river are the Porjus and the Horsprauget. The former has already been utilised to a considerable extent; the load, so far as three-phase current is concerned, amounts to 15,000 kw., and when certain extensions have been effected will reach double that figure. The Horsprauget project will furnish an additional estimated capacity of 192,500 kw. The falls, of which there are several in series, will be impounded in a single installation by the construction of a high dam, which will have the distinction of being larger than any hitherto constructed in Sweden. It will be 1 kilometre (1100 yards) long and about 40 metres

(130 ft.) above the ground at its highest point. By lowering the water-level two metres, a supply of 5,000,000 cubic metres (say 1,100,000,000 gallons) will be available, which is sufficient to equalise load variations during a period of twenty-four hours. The dam will be designed as a composite structure, with special features to resist ice-pressure, which is, of course, a vital consideration in such high latitudes. The aggregate surface area of all the lakes within the catchment area amounts to about 890 sq. km. (343 sq. miles), and the total catchment area to 9860 sq. km. (3805 sq. miles).

OUR ASTRONOMICAL COLUMN.

VENUS AND JUPITER.—The planets Venus, Jupiter, and Saturn are now finely displayed in the evening sky. Venus is situated in Aries, Jupiter in Gemini, and Saturn in Cancer. To the naked eye a very interesting spectacle will be afforded during the ensuing few weeks by the approach of Jupiter and Venus. At present they are distant about 60° from each other, but this interval is decreasing at the rate of slightly more than 1° each night. This is due to the easterly movement of Venus. It will prove an entertaining incident to watch the gradual approach of the two planets until their conjunction on the night of May 25, when they will be very little more than 2° distant from each other near the time of their setting at about 11.11 p.m.

COMETS OF THE JOVIAN FAMILY.—Schorr's comet (*d* 1918) adds another member to the ever-increasing group of short-period comets. Forty of these objects were previously known, but fewer than half of this number had been fully confirmed by observations of a second return to perihelion. Two orbits have been computed for Schorr's comet which differ in the period assigned, one giving 6·73 years and the other 5·86 years. Definitive elements will, no doubt, be calculated when the comet has passed beyond the range of further observations.

STAR CLUSTERS.—Dr. C. V. L. Charlier has made an investigation of the distances and configuration of clusters (Meddelanden, Lund Observatory, ser. ii., No. 19). Making the simple assumption that distance varies inversely as angular diameter, he finds a grouping of the non-globular clusters strikingly similar to that which he found some years ago for the B stars. This is a satisfactory confirmation of the previously accepted conclusion that the non-globulars are intra-galactic objects. Since the centres of the two systems (non-globulars and B stars) are in the same direction from the sun, it is a reasonable assumption that they are coincident, which enables the scale of the non-globular system (at first left arbitrary) to be determined. A second determination, fairly accordant with the first, is made by assuming the extent of the system in a direction perpendicular to the plane of the galaxy to be the same as that found for the B stars. In the galactic plane the distances range to 5000 L.Y., but the great majority are less than 3000. The greatest co-ordinates perpendicular to the plane are about 1600 L.Y., indicating the usually accepted bun-shaped figure. It is evident that the distances of individual clusters cannot be relied on, but it is interesting to note that the distance of the great double cluster in Perseus comes out as 400 L.Y., which is close to the distance deduced for Nova Persei from the rate of illumination of the surrounding nebula.

Treating the globular clusters in the same way, Dr. Charlier finds a configuration similar to that found by Dr. Shapley, but on the question of scale he is in strong opposition to him, insisting on the intra-galactic situation of the globulars, owing to their concentration in the great star-cloud of Sagittarius, and other features of their grouping. He is thus led to take the absolute magnitude of the brightest cluster stars as about $+8$, and to assert that the cluster variables are dwarfs, though the Cepheids with their similar light-curves are admittedly giants. Prof. Eddington's researches make it unlikely that stars of small mass could attain a sufficient temperature to have a negative colour-index, such as Dr. Shapley found in many of the cluster stars. However, the results of the latter are of such a startling and far-reaching character that it is all to the good, in the interests of the attainment of truth, that an astronomer of Dr. Charlier's eminence should hold a brief for the other side pending further light on some of the weaker links in Dr. Shapley's chain of reasoning.

WEATHER INFLUENCES ON THE WAR.

PROF. ROBERT DE C. WARD contributes an article on "Weather Controls over the Fighting during the Autumn of 1918" to the *Scientific Monthly* for January. This is the concluding communication of a series which has from time to time been noticed in NATURE, and deals with the weather to the time of the signing of the armistice by Germany. The author states his belief that "as a part of the scientific history of the great war, as full an account as possible should be kept of the meteorological conditions which affected the operations on all the battle-fronts."

The autumn of 1918 is stated to have been "in many respects the most critical season, meteorologically, of any period of equal length during the whole war." It was clear that the Allies were determined to force the defeat of the Germans whilst fighting weather lasted. The Allies, by pushing on, were gaining better ground and more shelter for their armies.

At the commencement of September despatches mentioned the "unprecedented dryness" which for about a week favoured the movements of the Allies, but the second week of September experienced heavy storms, which retarded progress. Throughout the war as autumn advanced the fighting conditions were less favourable, and the Flanders mud had proved an almost insurmountable obstacle. The distribution of the rainfall throughout the year at the Western Front is similar to that over the south-east of England, where the heaviest rains occur in the autumn season, the average rainfall of October being equal to that of February and March combined. Add to these conditions the drop of temperature, which on the Continent is much greater than in the British Isles, and the colder weather brings more snow and slush. The rivers are not uncommonly in flood, and, wherever possible, the enemy caused artificial flood, hampering and impeding the movements of the Allies.

Official despatches laid unusual stress on the unfavourable weather controls of the autumn, but probably much of this was due to the intense anxiety of the Allies to crush the enemy before winter set in. All bad weather was helping the enemy by delaying attack and enabling him to organise his retreat. The Monthly Weather Report of the Meteorological Office for September shows that the month was abnormally wet and very cold, whilst in many parts of England "the rainfall totals were the greatest ever measured, not only in September, but in any calendar month whatever." The map showing the movements of depressions over the British Isles and the adjacent parts of the Continent indicates a north-easterly track for the storm areas, and the Western Front appears to have escaped the passage of the storm centres. October was "dull, damp, and sunless." The rainfall was moderate, but the number of rain-days was excessive over the British Isles. Similarly, unsettled weather was, without doubt, experienced over Flanders. Notwithstanding almost incessant adverse weather controls, "there runs the splendid story of the advance of the Allied troops . . . one despatch (September 12) mentioned the pouring rains which forced the Allied airmen to cease their punishment of the Germans." The stormy and wet weather also greatly handicapped the activity of the Tanks. In the latter part of the autumn, and especially just prior to the armistice, fog was very prevalent, but it did not always prove adverse to the advance of the Allies, although at times it aided the retreating enemy. Short dry and fine spells intervening were very favourable controls, aiding the advance of the Allies in every way.

There was little activity on the Italian Front until late in October, and Prof. Ward states that "the reason for beginning the offensive at that time was doubtless to be sought in the political condition of Austria-Hungary." Military operations on this front ended on November 4.

In Palestine and Mesopotamia the co-ordinated movements of the Allied forces in the autumn led to the defeat of the Turkish armies, and Turkey was driven to surrender.

It would be a valuable scientific asset to have the "Weather Controls" by the author throughout the war brought together and published collectively.

C. H.

THE UNITED STATES NATIONAL MUSEUM.[1]

THE volume before us—the last report submitted by the late Dr. Rathbun as assistant secretary of the United States National Museum—contains no general observations of a striking character, but recounts a large amount of valuable work. There is a long list of accessions, but the numbers have not been summarised. From among them it is not easy to make a selection, but the following seem to be of superior importance:—The Julius Hurter bequest of 3575 reptiles and batrachians, comprising the material for Mr. Hurter's "Herpetology of Missouri" (1911), as well as many genera and species new to the museum; all are good specimens, and beautifully prepared. The Biltmore herbarium, or so much of it as was saved from the flood of July, 1916, presented by the widow of its founder, the late George W. Vanderbilt; the 25,000 specimens saved include many types of Cratægus species. The private collection of cryptogams formed and presented by Prof. O. F. Cook, and numbering about 15,000 specimens. The fine collection of meteorites brought together by Dr. Charles U. Shepard, and bequeathed by his son; it represents 238 falls and finds, some of exceptional interest. Dr. Shepard's extensive collection of minerals and gems remains on deposit in the museum, which is a conditional legatee.

As Dr. Rathbun most truthfully says in his introduction, "the importance of public collections rests, not upon the number of specimens, but upon the use to which they are put." On the educational side the United States National Museum pays great attention to the adequate selection, mounting, and labelling of objects. Of late it has done a good deal by way of models. We read here of a model showing the geology of a coral island, beside which has been erected a real fossil coral reef obtained from the Carboniferous rocks of Kentucky. In the court containing the wood collection are two new models of diverse character. One is part of a national forest, on a scale of 1/300, and measuring 12 ft. by 15 ft., designed to show the various uses of such forests and their administration. The other illustrates a modern plant for the preservative treatment of railway timber. Another model, 16 ft. by 19 ft., reproduces the works of the Bingham Cañon Copper Property, where lean copper ore of the disseminated type is now being worked at a profit. Other models illustrate the manufacture of white lead, and the mode of occurrence, recovery, and preparation of tin, sulphur, asphalt, lime, and oil. These latter, with their associated exhibits, eighteen in all, have been planned to convey an understanding of the various industries based on the mineral resources of the country. Others are in preparation, and explanatory bulletins are being widely distributed.

Another valuable series of exhibits peculiar to this museum is the collection illustrating the history of photography from the earliest times. We allude to this here because the report records the death of Mr. Thomas W. Smillie, who since 1871 had been the museum photographer. The enormous advantage to the educational and research work of a museum in having, not merely a photographic laboratory, but also a trained man of science at its head, can be but dimly apprehended by museum-workers in this country, so far are they from any approach to this.

This leads us to the second great use of the collections—namely, as the basis of research. The report contains, in thirty-seven double-columned pages, a "classified list of papers based wholly or in part on the national collections." A useful feature is the *précis* attached to many of the entries. In the account of work done we are glad to note the friendly co-operation between the National Museum of the United States and that of this country, as exemplified in Mr. Oldfield Thomas's study of the South American mammals.

Any comparison of the scientific output of these two museums would be a difficult matter, but we cannot refrain from noting that the purely natural history staff at Washington numbers fifty-two (exclusive of associates and honorary helpers), whereas that at our Natural History Museum is only forty-two.

[1] Report on the Progress and Condition of the United States National Museum for the Year ending June 30, 1917. Pp. 184. (Washington: Smithsonian Institution, 1918.)

THE PROBLEM OF RADIO-ACTIVE LEAD.[1]

I.

WE meet to-day with happiness which six months ago would have seemed beyond the bounds of reasonable hope. After anxious months the confidently awaited victory, which last spring still seemed far away, has crowned the cause of justice, truth, and liberty. We in America rejoice that this cause is our cause, and that at the most critical time we were able to render effective help to the staunch and brave Allied forces which had fought so long and so nobly.

The object of this address is not, however, to appraise the military issues of the great war so fortunately ending, or to deal with the weighty international problems now faced by the world, but rather to bring before you other considerations, having to do with the advancement of science.

[1] Presidential address to the American Association for the Advancement of Science, Baltimore, December, 1918, by Prof. Theodore W. Richards.

The particular subject chosen, namely, the problem of radio-active lead, is one of peculiar and extraordinary interest, because it involves a readjustment and enlargement of many rather firmly fixed ideas concerning the chemical elements and their mutual relations, as well as the nature of atoms.

Within the last twenty years the definition of these two words, "elements" and "atoms," has been rendered somewhat uncertain, and bids fair to suffer even further change. Both of them are ancient words, and both even a century since had acquired meanings different from those of long ago. Thales thought of but one element, and Aristotle's elements—earth, air, fire, water, and the quintessence, derived perhaps from yet more ancient philosophy—were not plentiful enough to account for all the manifold phenomena of Nature. Democritus's old idea of the atom was associated with the philosophical conception of indivisibility rather than with the idea of chemical combination in definite proportions. To-day many chemists and physicists think that the chemical atoms of the last century are no longer to be considered as indivisible. In that case, the old Greek name "atom" is no longer fitting, because it denotes indivisibility. Someone has even facetiously suggested that the word "tom"—indicating divisibility—would be more appropriate! Moreover, if our so-called atoms are really divisible, we cannot but be somewhat doubtful as to our definition of the ultimate elements of the universe. The reason for this new turn of thought is due, as you all know, to the discovery of the unexpected and startling phenomena of radio-activity.

To-night we have to deal with a substance directly concerned with the iconoclastic radio-active changes—with the very phenomena which cause us to stop and think about our definitions of atoms and elements. For the lead obtained from radio-active minerals appears to have resulted, together with helium, from the radio-active decomposition of elements of higher atomic weight. Sceptical at first, the whole chemical world has now come to acknowledge that the well-defined element helium (discovered by Sir William Ramsay twenty-three years ago) is one of the decomposition products of radium. Radium itself is a substance which, in many respects, acts as an element, with 226 as its atomic weight, and must be considered as the heaviest member of the well-known calcium family; but its atoms appear to be so big and so complex as to disintegrate because of lack of stability. The disintegration is slow, and not to be hastened or retarded by any agency known to man; 1670 years are demanded for the decomposition of half of any given portion of radium, according to the exact measurements of Profs. Boltwood and Ellen Gleditsch. Moreover, we have reason to believe that this decomposition proceeds in a series of stages, successive atoms of helium (five in all) being evolved with different degrees of ease by any given atom of radium. In the end most—indeed, probably all—of the residual part of the radium appears to have been converted into the peculiar kind of metallic lead with which we are concerned to-night. The nature of the end-product was first suggested by Boltwood, who pointed out the invariable presence of lead in radium minerals. Thus we must accept a kind of limited transmutation of the elements, although not of the immediately profitable type sought by the ancient alchemists.

Interesting and significant as all this is, nevertheless the whole story has not yet been told. Radium itself appears to come from the exceedingly slow decomposition of uranium, an inference drawn from the fact that radium is found only in conjunction with the uranium, which, even after careful purification, soon becomes radio-active, and gives every indication of suffering slow disintegration. Moreover, uranium is not the only other heavy element which appears to be capable of decomposing and yielding elements of lower atomic weight. Another, thorium, has a like propensity, although the steps in this case are perhaps not so fully interpreted, or so generally accepted. In the process of disintegration all these heavy atoms yield strange radiations, some of them akin to, or identical with, X-rays, which bear away that part of the colossal energy of disintegration not made manifest as heat. These facts have been proved beyond doubt by the brilliant work of Mme. Curie, Sir Ernest Rutherford, and others.

The nature of the rays and of the highly interesting evanescent transition products and their relation to one another are too complex for discussion now. We are concerned rather with the nature of the more permanent of the substances concerned, especially with the starting point, uranium (possessing the heaviest of all atoms), radium, and the lead which seems to result from their disintegration. Omitting the less stable transition products, the most essential outcomes are roughly indicated by a sort of genealogical tree herewith shown:—

Hypothesis Concerning the Disintegration of Uranium.

Uranium
↓ ↘ 3 Helium ⎫
Radium ⎪
↓ ↘ 1 Helium ⎬ 8 Helium
Emanation ⎪
↓ ↘ 4 Helium ⎭
Lead (Isotopic)

Thus each atom of uranium is supposed to be converted into radium by losing three atoms of helium, and each atom of radium is supposed to be converted into a kind of lead by losing five more, as already stated.

If uranium can thus disintegrate, should we call it an element? And should we call its smallest particles atoms? The answers depend upon our definition of these two words. If the word "element" is supposed to designate a substance incapable of disintegration, apparently it should not be applied to uranium; neither should the word "atom" be applied to the smallest conceivable particles of this substance. But no one would now maintain that any element is really incapable of disintegration. A method of still retaining the terms in this and analogous cases is to define an element as "a substance which has not yet been decomposed artificially"—that is to say, by the hand of man; and an atom as "the smallest particle of such a substance, inferred from physico-chemical behaviour." The atom, then, is not to be considered as wholly indivisible, but only as indivisible (or, at least, as not yet divided) by artificial means. For, as in the case of radium, the disintegration of uranium cannot be hastened or retarded by any known earthly agency. So long as it stays intact, the atom of uranium behaves quantitatively in the same fashion as any other atom; Dalton's laws of definite and multiple combining proportions apply without exception to its compounds. In this connection one should remember that the atomic theory as a whole, including Dalton's and Avogadro's generalisations, is not in the least invalidated by the new discoveries of radio-activity. On the contrary, the atomic theory is entrenched to-day more firmly than ever before in its history.

Interesting speculations by Drs. Russell, Fleck, Soddy, Fajans, and others have interpreted in extremely ingenious and plausible fashion the several transitory steps of the changes, and indicate the reasons why the end-products of the decomposition of both uranium and thorium should be very similar to lead, if not identical with it. Therefore, a careful study of the properties of lead of indubitably radio-active origin became a matter of great interest, as a step towards confirming these speculations, especially in comparison with the properties of ordinary lead. Such investigations should throw light on the nature of radium and uranium and the extraordinary changes which those metals suffer. Moreover, by analogy, the resulting conclusions might be more or less applicable to the relations of other elements to each other; and the comparison of this new kind of lead with ordinary lead might afford important information as to the essential attributes of elementary substances in general, in case any differences between the two kinds should be found.

Before the subject had been taken up at Harvard University chemists had already recognised the fact that the so-called uranium-lead is indeed qualitatively very like ordinary lead. It yields a black sulphide, a yellow chromate, and a white sulphate, all very sparingly soluble in water, just as ordinary lead does. Continued fractional crystallisation or precipitation had been shown by Prof. Soddy and others to separate no foreign substance. Hence great similarity was proved, but this does not signify identity. Identity is to be established only by quantitative researches. Plato recognised long ago, in an oft-quoted epigram, that when weights and measures are left out, little remains of any art. Modern science echoes this dictum in its insistence on quantitative data; science becomes more scientific as it becomes more exactly quantitative.

One of the most striking and significant of the quantitative properties of an element is its atomic weight—a number computed from the proportion by weight in which it combines with some other element, taken as a standard. There is no need, before this distinguished audience, of emphasising the importance of the familiar table of atomic weights; but a few parenthetical words about their character is, perhaps, not out of place. As has been said more than once, the atomic weights of the relatively permanent elements, which constitute almost all the crust of the earth, seem to be concerned with the ultimate nature of things, and must have been fixed at the very beginning of the universe, if, indeed, the universe ever had any beginning. They are silent, apparently unchanging, witnesses of the transition from the imagined chaos of old philosophy to the existing cosmos. The crystal of quartz in a newly hewn piece of granite seems, and probably is, as compact and perfect as it was just after it was formed æons ago. We cannot imagine that any of its properties have essentially changed during its protracted imprisonment; and, so far as we can guess, the silicon and oxygen of which it was made may have existed for previous æons, first as gas, and then as liquid. The relative weights in which these two elements combine must date at least from the inconceivably distant time when the earth was "without form and void."

Although, apparently, these numbers were thus determined at the birth of our universe, they are, philosophically speaking, in a different class from the purely mathematical constants such as the relation of circumference to the diameter of a circle. 3·14159... is a geometrical magnitude entirely independent of any kind of material, and it therefore belongs to the more general class of numbers, together with simple numerical relations, logarithmic and trigonometric quantities, and other mathematical functions. On the other hand, the atomic weights of the primeval elements, although less general than these, are much more general and fundamental than the constants of astronomy, such as the so-called constant of gravity, the length of the day and year, the proper motion of the sun, and all the other incommensurable magnitudes which have been more or less accidentally ordained in the cosmic system. The physico-chemical constants, such as the atomic weights, lie in a group between the mathematical constants and the astronomical "constants," and their values have a significance only less important than the former.

In the lead from uranium we have a comparatively youthful elementary substance which seems to have been formed since the rocks in which it occurs had crystallised. Is the atomic weight of this youthful lead identical with that of the far more ancient common lead, which seems to be more nearly contemporary as to its origin with the silicon and oxygen of quartz?

The idea that different specimens of a given element might have different atomic weights is by no means new; it far antedates the discovery of radio-activity.

Ever since the discovery of the definite combining proportions of the elements and the ascription of these proportions to the relative weights of the atoms, the complete constancy of the atomic weights has occasionally been questioned. More than once in the past investigators have found apparent differences in the weights of atoms of a single kind, but until very recently all these irregularities have been proved to be due to inaccurate experimentation. Nevertheless, even thirty years ago the question seemed to me not definitively answered, and careful experiments were made with copper, silver, and sodium, obtained from widely different sources, in the hope of finding differences in the atomic weights, according to the source of the material. No such differences whatever were found. More recently Prof. Baxter compared the atomic weights of iron and nickel in meteorites (from an unknown, perhaps inconceivably distant, source) and the same terrestrial metals. In these cases also the results were negative. Thus copper, silver, sodium, iron, and nickel all appeared to be perfectly definite in nature, and their atoms, each after its own kind, all alike.

The general question remained, nevertheless, one of profound interest to the theoretical chemist, because it involved the very nature of the elements themselves; and in its relation to the possible discovery of a difference between uranium-lead and ordinary lead it became a very crucial question.

Early in 1913, when the hypothesis of radio-active disintegration had assumed definite shape, Dr. Fajans's assistant, Max Lembert, journeyed to Cambridge, Mass., bringing a large quantity of lead from Bohemian radio-active sources in order that its atomic weight might be determined by Harvard methods, with the precision attainable there. The Carnegie Institution of Washington gave generous pecuniary assistance towards providing the necessary apparatus in this and later investigations.

The most important precautions to be taken in such work are worthy of brief notice, because the value of the results inevitably depends upon them. The operation consists in weighing specimens of a salt of the element in question, and then precipitating one of the constituents in each specimen, determining the weight of the precipitate, and thus the composition of the salt. In the first place, each portion of substance to be weighed must be free from the suspicion of containing unheeded impurities, otherwise its weight will mean little. This is an end not easily attained, for liquids often attack their containing vessels and absorb gases, crystals include and occlude solvents, precipitates carry down polluting impurities, dried substances cling to water, and solids, even at high temperatures, often fail to discharge their imprisoned contaminations. Especial care was taken that each specimen was as pure as it could be made, for impurity in one would vitiate the whole comparison.

In the next place, after an analysis has once begun, every trace of each substance to be weighed must be collected and find its way in due course to the scale-pan. The trouble here lies in the difficulty in estimating, or even detecting, minute traces of substances remaining in solution, or minute losses by evaporation at high temperatures.

In brief, "the whole truth and nothing but the truth" is the aim. The chemical side of the question is far more intricate and uncertain than the physical operation of weighing. The real difficulties precede the introduction of the substance into the balance-case. Every substance must be assumed to be impure, every reaction to be incomplete, every measurement to contain error, until proof to the contrary can be obtained. Only by means of the utmost care, applied with ever-watchful judgment, may the unexpected snares which always lurk in complicated processes be detected and rendered powerless for evil.

After all these digressions, made in order that the problems concerned should be clearly recognised, let us turn to the main object of our quest. In the present case each form of lead was first weighed as pure chloride, and the chlorine in this salt after solution was precipitated as silver chloride, the weight of which was determined. Precautions too numerous to mention were observed. Thus the weight of chlorine in the salt was found, and by difference the weight of the lead. From the ratio of weights the atomic weight of lead was easily calculated.

The outcome of the first Harvard trials, published in July, 1914, brought convincing evidence that the atomic weight of the specimen of uranium-lead from Bohemia is really less than that of ordinary lead, the value found being 206·6 instead of 207·2—a difference of 0·3 per cent., far beyond the probable error of experiment. Almost simultaneously preliminary figures were made public by Drs. Hönigschmid and St. Horovitz and by Maurice Curie, pointing towards the same verdict.

This result, interesting and convincing as it was, was only a beginning. Other experimenters abroad have since confirmed it, especially Prof. Hönigschmid, who had studied at Harvard and understood the necessary refinements of analysis; and many new determinations have been made at the Wolcott Gibbs Memorial Laboratory, with the assistance of Dr. Charles Wadsworth and Dr. Norris F. Hall, upon various samples of lead from radio-active sources in widely separated parts of the world. Messrs. E. R. Bubb and S. Radcliff, of the Radium Hill Co., of New South Wales, kindly sent a large quantity of lead from their radium mines, and a particularly valuable specimen prepared from selected crystals of pure mineral was put at our disposal by Prof. Gleditsch—not to mention other important contributions from others, including Prof. Boltwood and Sir William Ramsay. Each of these samples gave a different atomic weight for the lead obtained from them, and the conclusion was highly probable that they contained varying admixtures of ordinary lead in the uranium-radium-lead. This was verified by the knowledge that in at least some cases the uranium ore actually had been contaminated with lead ore. The purest Norwegian specimen thus acquired especial importance and significance, because it was only very slightly, if at all, vitiated in this way. As a matter of fact, it gave 206·08 for the atomic weight in question—the lowest of all. Here are typical results, showing the outcome; many more of similar tenor were obtained:—

Atomic Weights.

Common lead	207·20 207·19	207·19
Australian radio-active lead containing probably 25 per cent. ordinary lead ...	206·32 206·36 206·33 206·36	206·34
Purest uranic-lead	206·08 206·09	206·08

Hönigschmid, from similar pure material, had found figures (206·05) agreeing almost exactly with the last value. One cannot help believing that this last specimen of lead is a definite substance, probably in a state almost pure, because of the unmixed quality of the carefully selected mineral from which it was obtained.

A further question now arises: Is it a *permanent* substance—really an end-product of the disintegration? Soddy's hypothesis assumes that it is. The only important fact militating against this view is the observation that uranium-lead is always radio-active, and hence might be suspected of being unstable. In various impure specimens, however, the radio-activity is not proportional to the change in the atomic weight; hence the radio-activity is probably, at least in part, to be referred, not to the lead itself, but rather to contamination with minute, unweighable amounts of intensely radio-active impurities—other more transitory products of disintegration.[2] If weighable, such impurities would almost certainly *increase,* not *diminish,* the atomic weight; hence their presence could not account for the low value.

Let us compare the actual result for the atomic weight of this kind of lead with the theory of Soddy and Fajans. If this theory is sound, the simple subtraction of eight times the atomic weight of helium from that of uranium, or five times the atomic weight of helium from that of radium, should give the atomic weight of the lead resulting from the disintegration as follows:—

Hypothetical Calculation of Atomic Weight of Uranium-lead.

Atomic weight of uranium	=238·18	
8 × atomic weight of helium	= 32·00	
Residue (lead?)	206·18	=206·18
Atomic weight of radium	=225·96	
5 × atomic weight of helium	= 20·00	
Residue (lead?)	205·96	=205·96
Average hypothetical value for lead... ...		=206·07
Observed value for uranium-lead[3]		=206·08
Difference		0·01

The agreement is remarkably good. Each of the individual calculated values shows less than 0·05 per cent. deviation from the average, and the average itself shows essential identity with fact—a striking confirmation of the theory. This is, perhaps, the most successful attempt on record to compute an atomic weight from hypothetical assumptions. Usually we are wholly at a loss as to the theory underlying the precise relationships, and must determine our values by careful experiment alone.

[2] For this reason the term "radio-active lead," although it describes the fact, is from a theoretical point of view perhaps not the best designation of either uranium- or thorium-lead; but the term is convenient, because it distinguishes between these two forms and common lead.

[3] This is the Harvard result. If Hönigschmid's value is given equal weight, the average observed value would be 206·07, exactly identical with the hypothetical value.

The value 206·08 for the atomic weight of lead has further support in the fact that it is more nearly half-way between thallium, 204, and bismuth, 208, the two neighbouring elements in the periodic system, than is the atomic weight 207·2 possessed by ordinary lead.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. E. Inglis, fellow of King's, has been elected professor of mechanism and applied mechanics in succession to the late Prof. Bertram Hopkinson.

EDINBURGH.—A gift of 10,000*l.* from a donor who desires to remain anonymous has been presented to further progress in the study and teaching of some subject related to surgery by endowing a lectureship in orthopædics.

An offer of 15,000*l.* for the foundation of a chair in accounting and business method has been made by the following public bodies:—Edinburgh Chamber of Commerce, the Edinburgh Merchant Company, Leith Chamber of Commerce, Leith Shipowners' Society, the Society of Accountants in Edinburgh, and the Institute of Bankers in Scotland. A draft ordinance for the foundation of this chair was submitted along with other draft ordinances for the foundation of chairs in psychiatry, forestry, and zoology.

A proposal to purchase a site for the extension of the University has been approved.

Dr. A. E. Sprague has been appointed University lecturer in actuarial science.

Mr. A. S. Stenhouse and Major Walter Bisset have presented to the Geology Department valuable collections of minerals, rocks, and fossils.

NOTTINGHAM.—Prof. A. W. Kirkaldy, of Birmingham University, has been appointed professor of economics and commerce at University College in succession to Prof. J. A. Todd, who has accepted a position under the Board of Trade.

OXFORD.—Two important professorships are at present vacant in the University, and in each case the electors intend to proceed to an election in Easter week. These are the professorship of experimental philosophy and Dr. Lee's professorship of chemistry. The stipend attached to each chair is 900*l.* a year. Candidates are requested to send in their applications, with such evidence of their qualifications as they may desire to submit, to the Registrar of the University, University Registry, Oxford, so as to reach him not later than March 31. *Ten* copies of the letter of application, and of any testimonials submitted, should be sent. The duty of the professor of experimental philosophy, who will have charge of the Clarendon laboratory, will be to give instruction chiefly on mechanics, sound, light, and heat. That of Dr. Lee's professor of chemistry will be to give instruction chiefly in inorganic and physical chemistry.

The numbers of undergraduates during the term just past have been about half the usual strength. It is expected that the normal numbers will be reached, and perhaps exceeded, in the term that begins on April 25.

DR. H. PRINGLE, chief assistant to the professor of physiology and lecturer in histology in the University of Edinburgh, has been elected King's professor of the Institutes of Medicine in the School of Physic in Ireland.

THE New York correspondent of the *Times* announces that Yale and Princeton Universities have decided to abolish the principle of compulsory Latin in the curriculum. It will now be possible to obtain any degree without that language, with the exception of the arts degree at Princeton. At all other examinations the candidates will be permitted to offer a modern language instead of Latin. Princeton will also abolish compulsory Greek in the examination for an arts degree.

ON March 19 Mr. Fisher, President of the Board of Education, delivered a lecture arranged by the Industrial Reconstruction Council on "The Functions of Government in Relation to Education." During the course of his remarks Mr. Fisher said that in the near future it may be found possible to increase Treasury grants to the universities and to extend encouragement to scientific research in all fruitful directions. We have now reached a point in educational development at which it is clear that the universities will be compelled to accept a larger measure of State assistance than has hitherto been afforded to them to meet the needs in certain important branches of scientific development. For instance, trained meteorologists are needed for aviation purposes, trained marine physicists in connection with submarines, and hydraulic engineers for the proper use of our waterways. What is the solution to the many problems which present themselves? Mr. Fisher has come to the conclusion that it partly depends upon the intelligent co-operation of the universities themselves, but partly that intelligent co-operation must be assisted by the gentle and indirect pressure exercised by the distribution of Treasury grants to the universities willing to receive them; and he intends, in collaboration with the Secretary for Scotland and the Chief Secretary for Ireland, to set up a Committee which will distribute grants to universities in the administration of which there will be some opportunity to give counsel to the universities as to a particular line of development in the pursuit of which they are most likely to contribute to the common weal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 13.—Sir J. J. Thomson, president, in the chair.—Dr. A. D. **Waller**: Concerning emotive phenomena. Part iii.: The influence of drugs upon the electrical conductivity of the palm of the hand.—Dr. W. L. **Balls**: The existence of daily growth-rings in the cell-wall of cotton hairs. The probability that such growth-rings existed had been formerly deduced from studies upon the physiology and environment of the cotton-plant in Egypt; but, since their thickness must be sub-microscopic, direct evidence was unobtainable until recently. By swelling the wall in hydration following formation of cellulose xanthate, by counting the layers thus magnified in thickness, and by comparative studies on the fuzz-hairs, it is shown that each such ring corresponds with the cellulose laid down during one night's growth. The existence of variation as to kind or texture of cellulose thus shown to exist within the thickness of the wall, repeated some twenty-five times in the adult hair, necessitates reconsideration of many chemical and physical aspects of cellulose problems.

Geological Society, March 12.—Mr. G. W. Lamplugh, president, in the chair.—Lieut. E. H. **Pascoe**: The early history of the Indus, Brahmaputra, and Ganges. From geological indications the author concludes that the first effect of the commencement of the Himalayan uplift was the establishment of a great westward-flowing river along the southern face of the range, for which he proposes the name of Indobrahm. The distribution of Tertiary rocks on the northern side of the range suggests that here also a westward-flowing river was formed, which either discharged round the end of the range into the same sea as the Indobrahm, or flowed westwards into the region of Turkestan and the Caspian Sea. The later history of the drainage system consists of the capture of the upper waters of this river by a tributary of the Indobrahm, a cutting-back along the valley to form the eastward-flowing Tsangpo, now the upper waters of the Brahmaputra, and the capture of the lower reaches in part by the Sutlej and in part by the Attock tributary of the Indobrahm, to form the Himalayan portion of the Indus valley. Meanwhile, on the southern side of the range, some of the tributaries on the eastern side of the Lower Indobrahm had cut back from the Sind region and cut off the original bend near Attock, to form the present plains of the Punjab; and farther east a river cutting back along the present line of the Gangetic delta and lower course of the Ganges and Brahmaputra had captured the upper waters of the Indobrahm to form the present Brahmaputra. The same system of capture had worked westwards, until the tributaries of the Indobrahm had been successively diverted from a westerly to an easterly drainage up to and including the Jumna River.—Dr. A. Smith **Woodward**: Fish-remains from the Upper Devonian (Pickwell-Down Sandstones) of Woolacombe Bay (North Devon). The remains were discovered by Mr. Inkerman Rogers, and noticed by him in the *Geological Magazine* for March, 1919.

Royal Meteorological Society, March 19.—Sir Napier Shaw, president, in the chair.—Prof. L. **Hill**: Atmospheric conditions which affect health. Numerous observers make records of barometric pressure, temperature, rainfall, wind, etc., but the question arises as to whether there are not other data of greater importance and interest which affect personal health and comfort, and might be recorded. In the past much has been made of the chemical alteration of the air in crowded places, and unsound views have become popular. The victims of the Black Hole of Calcutta died from heat-stroke, not from a poisonous vitiation of the air by the exhalations of the crowd. It is the cooling and evaporative power of the atmosphere and the radiant heat of the sun, or other source of radiant energy, which affect our comfort and well-being, and it is these factors which require to be measured by the student of hygiene. The dry-bulb temperature does not suffice to indicate the cooling effect, because it is a static instrument averaging the influence of the environment, while the body is a dynamic instrument keeping itself at a nearly constant body-temperature by the internal combustion of food and by heat loss from the skin and respiratory membrane, the heat gain and loss both being physiologically controlled. It is cooling power acting on the body-surface, not temperature, which we require to study; and as the surface of the respiratory membrane is always wet, and the skin may be made relatively dry or very wet by physiological control, evaporative cooling is of no less importance than cooling by convection and radiation. To estimate cooling power the author has introduced the kata-thermometer.

PARIS.

Academy of Sciences, March 3.—M. Léon Guignard in the chair.—M. **Hamy**: The study of the perturbations of the optical axis of a meridian telescope. An arrangement of two doubly reflecting prisms is described, which permits the total value of the errors due to the imperfections of the telescope to be determined.—A. **Rateau**: The successive states of a gas at high pressure in a receptacle which is emptied by a jet.—A. **Blondel**: The free oscillations of alternators on a network at constant pressure.—E. **Ariès**: The application to eight different substances of the formula which expresses the heat of evaporation of a liquid. The substances chosen are carbon dioxide, ammonia, stannic chloride, methyl formate, and pentane and its three next higher homologues. A table is given showing the agreement between the calculated and published experimental values.—Louis Fabry was elected a correspondant for the section of astronomy in succession to the late M. Backlund.—R. **Garnier**: The irregular singularities of linear differential equations.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the fourth quarter of 1918. The observations made on sixty-seven days during this quarter are grouped in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—L. **Dunoyer** and G. **Reboul**: The prediction of barometric variations.—G. **Guilbert**: The anomalies of the meteorological station of Skudesness (Norway). The station of Skudesness is the only meteorological station in Europe where the known laws governing the direction and force of surface winds are frequently found to fail. The author suggests that the abnormal winds at this station reveal the existence of very distant cyclonic disturbances, situated west of the British Isles and showing no indication here. On certain days the data from the Skudesness station alone can be used to predict the arrival of a storm.—D. **Faucher**: Contribution to the determination of the lacustral levels of the lower valley of the Vardar.—S. **Stéfanescu**: The transversal sections of the plates of molars.—Mme. Dolorès **Cebrian de Besteiro** and M. **Michel-Durand**: The influence of light on the absorption of organic material of the soil by plants. It has been previously shown that the pea cannot adapt its chlorophyll assimilation to feeble illumination. It is now found to be equally incapable of increasing the absorptive power of its roots in such a manner as to extract from the soil a larger quantity of organic carbon.—J. **Eriksson**: Biological and systematic studies on the Swedish Gymnosporangium.—F. **Maignon**: Study of the mechanism of the action of fats in the utilisation and assimilation of albuminoids. It has been shown in preceding communications that fats exert a double influence on the albuminoids of food; they diminish their toxicity and increase their nutritive power. The view is put forward that the fatty acids arising from the fats can combine with the amino-acid nucleus of a protein, thus leading to the formation of specific albumens. The author does not regard the view put forward by Crevat, J. Kuhn, and others that fats favour the digestion of albuminoids by stimulating the secretion of digestive juices as sufficient.—A. **Paillot**: Parasitic coccobacilli of the caterpillars of *Pieris brassicae*. During the great invasion in 1917 by *P. brassicae* opportunity was taken to isolate a certain number of parasitic micro-organisms. Details of five new species are given.

BOOKS RECEIVED.

Manual of Vegetable-garden Insects. By C. R. Crosby and M. D. Leonard. Pp. xv+391. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) 12s. 6d. net.

Fermat's Last Theorem: Three Proofs by Elementary Algebra. By M. Cashmore. Revised edition. Pp. 55. (London: G. Bell and Sons, Ltd.) 2s. 6d. net.

Army Gardens in France, Belgium, and Occupied German Territory. Their Making and Management, with Plans and Directions Suited to the Garden Service of the British and American Expeditionary Forces.

By Georges Truffaut, with the collaboration of Helen Colt. Pp. 65. (Versailles: Œuvre des Pépinières Nationales du Touring-Club de France, 1919.)

Botany: A Text-book for Senior Students. By D. Thoday. Second edition. Pp. xix+524. (Cambridge: At the University Press, 1919.) 7s. 6d. net.

The Principles of Mental Hygiene. By Dr. William A. White. With an Introduction by Dr. S. E. Jelliffe. Pp. xiv+323. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) 10s. 6d. net.

Eléments de Botanique. Par Prof. Ph. Van Tieghem. Cinquième Edition. Par Prof. J. Costantin. Tome i.: Botanique Générale. Pp. xv+619. Tome ii.: Botanique Spéciale. Pp. xx+743. (Paris: Masson et Cie, 1918.) 14 francs.

The New Physiology and Other Addresses. By Dr. J. S. Haldane. Pp. vii+156. (London: Charles Griffin and Co., Ltd., 1919.) 8s. 6d. net.

Conscience and Fanaticism: An Essay on Moral Values. By George Pitt-Rivers. Pp. xvi+112. (London: William Heinemann, 1919.) 6s. net.

The Elementary Nervous System. By Prof. G. H. Parker. (Monographs on Experimental Biology.) Pp. 229. (Philadelphia and London: J. B. Lippincott Co., 1919.) 2.50 dollars net.

Formulaire de l'Electricien et du Mécanicien. Par Hospitalier et Roux. Vingt-neuvième édition par Gaston Roux. Pp. ii+1485. (Paris: Masson et Cie, 1919.) 20 francs.

My House in the World: Essays in Quiet. By James Guthrie. Pp. 160, with ten drawings by the author. (London: Heath, Cranton, Ltd., n.d.) 5s. net.

Annuaire de l'Observatoire Royal de Belgique. Publié sous la direction de G. Lecointe. Pp. x+532+plates v. (Bruxelles: Hayez, Imprimeur de l'Observatoire Royal de Belgique, 1915.)

Annuaire de l'Observatoire Royal de Belgique. Publié sous la direction de Paul Stroobant. Pp. viii+209. (Bruxelles: Hayez, Imprimeur de l'Observatoire Royal de Belgique, 1919.)

Education: Secondary and University. A Report of Conferences between the Council for Humanistic Studies and the Conjoint Board of Scientific Societies. By Sir Frederic G. Kenyon. Pp. 47. (London: John Murray, 1919.) 1s. net.

A System of Physical Chemistry. By Prof. W. C. McC. Lewis. Second edition. In three volumes. Vol. iii.: Quantum Theory. With two appendices by James Rice. (Text-books of Physical Chemistry.) Pp. viii+209. (London: Longmans, Green, and Co., 1919.) 7s. 6d. net.

A Handbook of Colloid Chemistry. The Recognition of Colloids, the Theory of Colloids, and their General Physico-Chemical Properties. By Dr. Wolfgang Ostwald. Second English edition. Translated from the third German edition by Prof. Martin H. Fischer. With numerous notes added by Emil Hatschek. Pp. xvi+284. (London: J. and A. Churchill, 1919.) 15s. net.

Molecular Physics. By Dr. J. A. Crowther. Second edition. (Text-books of Chemical Research and Engineering.) Pp. viii+190. (London: J. and A. Churchill, 1919.) 6s. net.

Golden Days from the Fishing-Log of a Painter in Brittany. By Romilly Fedden. Pp. xviii+233. (London: A. and C. Black, Ltd., 1919.) 7s. 6d. net.

Sir William Turner, K.C.B., F.R.S., Professor of Anatomy and Principal and Vice-Chancellor of the University of Edinburgh. A Chapter in Medical History. By Dr. A. Logan Turner. Pp. xv+514. (Edinburgh and London: William Blackwood and Sons, 1919.) 18s. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Prof. C. H. Lees: Fire Cracks and the Forces Producing Them.

ROYAL SOCIETY, at 4.30.—H. L. Hawkins: The Morphology and Evolution of the Ambulacrum in the Echinoidea.—Dr. R. McCarrison: The Genesis of Œdema in Beriberi.

CHEMICAL SOCIETY, at 4.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—The late H. R. Constantine: The Co-ordination of Research in Works and Laboratories.

FRIDAY, MARCH 28.

PHYSICAL SOCIETY, at 5.—Discussion on Metrology in the Industries. Introduced by Sir R. T. Glazebrook.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting), at 7.—Dr. J. F. Crowley: The Organisation of Technical Engineers.

SATURDAY, MARCH 29.

ROYAL INSTITUTION, at 3.—Sir J. J. Thomson: Spectrum Analysis and its Application to Atomic Structure.

MONDAY, MARCH 31.

ROYAL SOCIETY OF ARTS, at 4.30.—Prof. H. E. Armstrong: Problems of Food and their Connection with our Economic Policy.

TUESDAY, APRIL 1.

ROYAL INSTITUTION, at 3.—Prof. A. Keith: British Ethnology—The People of Scotland.

WEDNESDAY, APRIL 2.

ROYAL SOCIETY OF ARTS, at 4.30.—W. N. Boase: The Cultivation and Preparation of Flax, and the Linen Industry.

THURSDAY, APRIL 3.

ROYAL INSTITUTION, at 3.—Prof. A. Findlay: Colloidal Matter and its Properties.

LINNEAN SOCIETY, at 5.—W. B. Brierley: An Albino Mutant of *Botrytis cinerea*.—Dr. J. D. F. Gilchrist: The Post-Puerulus Stage of *Jasus lalandii*.—Montagu Drummond: The Ecology of a Small Area in Palestine.

CHILD-STUDY SOCIETY, at 6.—Dr. E. Pritchard: Home *v.* Institutional Training of Young Children.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Lt.-Col. A. G. T. Cusins: The Development of Army Wireless during the War.

CHEMICAL SOCIETY, at 8.

SATURDAY, APRIL 5.

ROYAL INSTITUTION, at 3.—Sir J. J. Thomson: Spectrum Analysis and its Application to Atomic Structure.

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