THURSDAY, APRIL 12, 1917.

## TWENTIETH-CENTURY CHEMISTRY.

*Chemical Discovery and Invention in the Twentieth Century.* By Sir William A. Tilden. Pp. xvi+487. (London: George Routledge and Sons, Ltd., n.d.) Price 7*s.* 6*d.* net.

THIS book is an attempt to make clear to the general reader the nature of the work of the chemist. That ubiquitous person known as the "man in the street" probably considers that he already knows, at least in general terms, what that work is. The business of a chemist, he would probably say, is to vend tooth-brushes, sponges, photographic appliances, perfumes, and other "leading lines," drugs and poisons, and to make up prescriptions. He might add that the chemist is a person who seeks to combine the pretensions of a profession with the instincts of a shopkeeper.

The object of Sir William Tilden's book is to show that there are chemists and chemists. What our friend the "man in the street" regards as a chemist is, strictly speaking, an apothecary or a pharmacist, and his business nowadays has little or nothing to do with that of the chemist properly so called. There was a time when the two occupations had much in common. We owe to the labours of old-time apothecaries, especially in Scandinavia, France, and Germany, many notable advances in chemical knowledge, but leaders in chemical science in this country were, until a couple of generations ago, for the most part cultured persons of leisure and position, like Boyle, Hales, and Cavendish, or connected with teaching, like Black, Priestley, and Dalton. If the records of chemical discovery are searched, it will be found that the apothecaries in this country, unlike their fellows on the Continent, have contributed comparatively little to the common stock of chemical knowledge.

It is not our present purpose to indicate the reasons for their comparative neglect of a science which constitutes the very basis of the business of pharmacy, or to show why so little advantage is taken by apothecaries, as a class, of the opportunity it affords them for chemical inquiry. One reason, perhaps, may be found in the very different professional position which the apothecary holds in this country as compared with his Continental brother. But, be this as it may, our immediate point is to insist that our apothecaries have no moral claim to the title of chemist—a title, by the way, never assumed by their Continental brethren, in spite of their superior professional status.

But, although this confusion in the public mind as to the true vocation of the chemist is practically widespread, passing events have served somewhat to enlighten it. The newspapers have taught it that a chemist is a person concerned also with high explosives, noxious gases, dyes and certain drugs which the *soi-disant* chemist is unable to prepare. The "man in the street" had begun to recognise, even before the advent of Sir William Tilden's book, that there are chemists and chemists—chemists whose sole concern is, or should be, with pills, potions, and plasters; and chemists who have merely a vicarious interest in these things, and then only as members of a suffering humanity. This growing recognition of the divergent aims of chemists is meanwhile somewhat unsettling; it is confusion worse confounded. The simplest way to end it would be to amend the Pharmacy Act of 1868, or take some other steps to induce the druggists and pharmacists to drop their assumption of the title of chemist.

Pending such a consummation, we commend the book under review to the general attention of the public. A perusal of its interesting pages will serve to dispel any lingering doubts as to the proper function of a chemist. The author, in a short but suggestive introductory chapter, rapidly traces the change in the public attitude towards science, and in particular chemistry, as an instrument of education. In spite of checks and hindrances due to conservatism and the opposition of vested interests, the record as a whole makes cheerful reading. Steady progress has been made during the past three or four decades, and the movement is progressing at an accelerated rate, largely through the impetus given to it by the crisis through which this country is passing. It is this circumstance which renders the publication of Sir William Tilden's book so opportune. The lesson it seeks to convey is of the highest national importance. The author's greatest difficulty is how best to convey it. The theme is lofty and inspiring, but the material is vast and complicated, and it has required no small degree of skill and judgment to present it in an orderly and systematic manner, not overcharged with technicalities, and yet free from the ambiguities and loose statements of so-called popular writing. In this respect we think the author has been successful. There are, of course, certain sections which the lay reader who has lost the student-habit may have some little difficulty in grappling with. Questions of chemical constitution and representations of structural formulæ are, of course, beyond the range of even a well-educated man of to-day. Nevertheless, the author makes no assumption of previous knowledge on the part of his reader, but, with the skill of an experienced expositor, gradually builds up a presentation that with a little patient application becomes perfectly intelligible.

The main body of the work is divided into four parts. Part i. deals with chemical laboratories and the work done in them. The laboratories are classified as laboratories for general teaching and laboratories for special purposes. As types of the first class the author enumerates all the more important laboratories at home and abroad, and selects for special description the chemical laboratories of the Imperial College of Science and

Technology at South Kensington, the Royal College of Science for Ireland, the Universities of Harvard, Illinois, and of Sydney, Australia, and gives photographs of their respective elevations and internal arrangements. As types of laboratories for special purposes he describes, with illustrations, those of the Brewing School of the University of Birmingham, of the Manchester Municipal School of Technology, and of the Berlin Technical High School. A full account is given of the appointments and work of the Government Laboratory in Clement's Inn Passage, with numerous illustrations of the special apparatus employed there, as well as a digest of one of the annual reports of the Chief Chemist as illustrating the great variety of chemical work now needed by the Government. This section concludes with a short account of certain instruments and apparatus, with particular reference to the most recent appliances and developments.

Part ii., comprising ten chapters, extending in all over 125 pages, deals with modern chemical discoveries and theories. A short sketch of the history of chemistry and of the development of its principles occupies about a dozen pages. This is necessarily highly condensed—a mere *aperçu* done with the lightest possible touch. But no significant feature is left unnoticed, although some of the most momentous of new departures are dismissed in a dozen lines. The exigencies of his subject—chemical discovery and invention in the twentieth century—together with limitations of space, have, no doubt, imposed what at first sight seems a certain want of proportion in the treatment of the subject-matter. The lay reader who desires to realise what is the work of the chemist is really as much concerned with the broad fundamental truths upon which the science rests as he is with electrons and isotopes. But Sir William Tilden presumably has had to conform to the title imposed upon him by the circumstance of a companion volume under a somewhat similar title, and what his reader may lose in chap. iv. he gains abundantly in the rest of this particular series. In some eight or nine chapters he is treated to a full and clear description of those discoveries which have already made this epoch one of the most remarkable—perhaps *the* most remarkable up to now—in the history of science. The chapters on electric discharge in gases, on the chemical elements, on the discovery and properties of radium, and on the genesis and transmutations of the elements together deal with facts and theories which have shaken the very foundations of the science, and of which the outcome is not yet. The whole story has been put together in an admirable manner, and constitutes one of the most fascinating sections of the work.

Part iii. deals with the utilitarian aspects of chemistry, particularly with some of the more interesting or more important of its modern applications. The mass of material to be dealt with is necessarily very large, and in spite of the severest condensation, this section is the longest in the book. It ranges over such diverse subjects as the modern uses of hydrogen, oxygen, and nitrogen, the luminosity of flames, the incandescent-mantle industry, petrol, coal-tar, synthetic dyes and drugs, perfumes, cellulose, rubber, and explosives. This section constitutes very attractive reading. It is excellently illustrated with well-chosen photographs, and has been brought up to date as regards processes and statistical information. Within the limits of 150 pages no more illuminating or instructive account of the trend of modern chemical application could be given. It is as full of meat as an egg.

The last section of the book is devoted to a comparatively short account of modern progress in organic chemistry, and considering what modern organic chemistry has become, there is probably no section which has cost the author more trouble and thought. Of course, there are whole sections of this branch of chemistry which make no appeal to a general reader. Its problems are for the most part purely academic, and are not capable of being stated in terms intelligible to the lay mind. Sir William Tilden has, therefore, wisely confined himself to certain special sections, some of which, like that of sugar, might equally have found a place in the preceding part. Still, the subject enables a short account to be given of the chemistry of sugars in general, and of the mutual relations and constitution of the members of the several groups. Other chapters are on the proteins, enzymes, and natural colours, in which, considering the restricted space, a sound and accurate statement of present-day knowledge is given.

We congratulate the author on the production of a work as useful as it is accurate and interesting. The book is admirably got up and excellently illustrated, and constitutes a worthy and timely addition to popular chemical literature.

## BRITISH PLANTS AND BOTANICAL TERMS.

(1) *Illustrations of the British Flora: a Series of Wood Engravings, with Dissections, of British Plants.* Drawn by W. H. Fitch, with additions by W. G. Smith. Fourth (revised) edition. Pp. xvi+338. (London: L. Reeve and Co., Ltd., 1916.) Price 9*s*. net.

(2) *A Glossary of Botanic Terms, with their Derivation and Accent.* By Benjamin D. Jackson. Third edition. Pp. xii+427. (London: Duckworth and Co., 1916.) Price 7*s*. 6*d*. net.

(1) THE figures prepared by W. H. Fitch for the original illustrated edition of Bentham's "Handbook of the British Flora" have become one of the traditions of British botany. Remarkably compact, and for their size admirably depicting the important features in habit and characters of flower and fruit, they have proved one of the most widely used aids to the identification of British plants. Mr. W. G. Smith,

who is responsible for the additional drawings necessary to bring the book more into line with modern requirements, is well known for his power of depicting the salient features of a plant-subject. The new edition is of a similar handy size and form to the last, but some new features, to which reference is made in the preface, have been added with the object of increasing its usefulness. These comprise the reproduction from the "Handbook" of an "Arrangement of Natural Orders," with some of their distinguishing characteristics, and the addition of a few synonyms and the English name below the scientific name by which each plant is known in the "Handbook." In the matter of arrangement and nomenclature the "Illustrations" must naturally follow the companion "Handbook," which is recognised as the most conservative of the British "Floras." But it is to be regretted that an opportunity has not been found for re-arranging in both "Handbook" and "Illustrations" the system of classification so as to bring it more into accordance with modern views. The Conifers still appear as the last family of Dicotyledons, and the catkin-bearing families are all grouped under the one family Amentaceæ. The English names are still, in many cases, those invented by Bentham—that is, merely translations of the Latin name, and in no sense popular names. There is evidence of want of care in proof-reading in such names as *Anacharis Alismastrum, Spiranthes Romazoriana,* and *Orchis muscula*; the first is quite a new name, and it will puzzle the editor of a future supplement to the "Kew Index" to know to whom it is to be credited, as the book has no author; the names of Messrs. Fitch and W. G. Smith appear alone on the title-page, and the preface is anonymous.

(2) A new edition of Dr. Jackson's "Glossary of Botanic Terms" is always welcome, if only for the opportunity which it gives a reviewer of expressing on behalf of botanists generally their gratitude for one of the most used and useful works of reference. Apart from the tremendous labour involved in the gathering and arrangement of the material, there is the ever-present difficulty as to what terms are to be included and what omitted. The rise and development of a new branch of the science, such as œcology (which Dr. Jackson, following botanical custom rather than orthography, cross-references to ecology), with its almost startling fecundity in new terms, must be viewed with consternation by the compiler of a glossary. Dr. Jackson has steered a safe course between unduly increasing the size of his book and omitting useful references, and there are few terms, apart from those which are self-explanatory, which the botanist will not find indexed and explained in the new edition of the "Glossary." Botanists will be surprised to hear of the extent to which their terminology has grown; the total numbers included by Dr. Jackson amount to nearly 21,000, though many of these are archaic or have never been generally accepted. Almost any page opened at random will reveal strange or little-known terms, *e.g.* "drusy," a term used by one author to express the appearance of the stigma of *Orobanche caryophyllea,* while on the same page we notice four variants for the familiar "drip-tip" of a leaf. "Ennobling" is an old term for inarching; and "entrance," the outer aperture of a stoma, seems unnecessary; as also does "equilateral," equal-sided—one wonders what other meaning this could have even in botany.

Botanists can help Dr. Jackson in two ways: by informing him of any presumed omission from his "Glossary," and by refraining from making new terms except when necessary. There are a useful appendix on signs and abbreviations, another on the use of the terms "right" and "left," and a bibliography, the items in which are arranged chronologically.

## OUR BOOKSHELF.

*Bengal, Bihar and Orissa, Sikkim.* By L. S. S. O'Malley. (*Provincial Geographies of India.*) Pp. xii+317. (Cambridge: At the University Press, 1917.) Price 6*s.* net.

THE present volume is a valuable addition to this useful series, already represented by Mr. Thurston's account of Madras, and that of the Panjab by Sir J. Douie. Special difficulties prevented the earlier issue of Mr. O'Malley's volume. While the book was under preparation the re-shuffling of boundary-lines in 1912 resulted in the obliteration of the artificial partition set up in 1905; Assam was again made independent, while Eastern and Western Bengal were constituted into a governorship, and Bihar and Orissa became a new province. The general reader, with his attention concentrated on Calcutta and Dacca, thinks of Bengal as a land of rice and jute swamps built up by the action of the rivers Ganges and Brahmaputra, occupied by an effeminate race best known to us in Macaulay's classical description. But all Bengal, as now constituted, is not confined to the Sundarbans and the eastern districts. There are a hilly region on the south-east and the great Himalayan chain to the north, while Bihar, with its stalwart peasantry and its wide tracts of rice, maize, wheat, and barley, presents a startling contrast to the conditions of the Delta.

Of this varied region, with its physical differences, its many races and castes and religions, its history, archæology, social and industrial life, Mr. O'Malley gives a valuable account, illustrated by a fine series of photographs. The book adds new life and interest to the crude facts and statistics embedded in provincial gazetteers, census and administrative reports. The universal craving for litigation, the adaptiveness of the Bengali, the intensity of his religious life shown in the growth of new sects, the Mongoloid strain appearing in the east and combined with that of the Aryan to form the people of Bihar, the old-fashioned religious and social institutions of Orissa—of all these things Mr. O'Malley gives a readable description.

The book is sure to be largely used in English and Indian schools and should be in the hands of every young officer posted to India, while, studied by all who are interested in the progress of the Empire, it should remove many current misapprehensions and bring to the notice of home readers some idea of the weighty and complex problems which the Civil Service, patiently and without advertisement, has hitherto solved with conspicuous success.

*High-speed Internal-combustion Engines.* By A. W. Judge. Pp. ix+350. (London: Whittaker and Co., 1916.) Price 15*s*. net.

THIS book opens with a general discussion on the thermodynamic principles involved in the properties of gases and mixtures of gases, followed by a chapter descriptive of experiments on rates of combustion, etc., in the engine cylinder. Working cycles and the conditions occurring in actual engines are then treated; this section has a useful collection of experimental data on the losses due to different parts of the engine mechanism and to the friction of gases flowing along passages. A section on pressures and temperatures follows, and has many references to well-known experiments. Chap. v. deals with indicators and indicator diagrams, and has useful descriptions of modern high-speed indicators. The remaining two chapters deal with the mechanics of the engine and with balancing.

The volume is intended to form a companion to one upon the design of high-speed internal-combustion engines, and possibly this explains the absence of drawings descriptive of typical engines. We should hesitate to recommend the book to students until the opportunity arises of examining the proposed companion volume. The practical engineer will not much appreciate the almost total absence of reference to brake-horse-powers, and to the special methods of measuring them which have to be adopted in high-speed motors. There are several minor blemishes. Thus on p. 1 various heat units are defined, including the British thermal unit, and omitting the lb.-deg.-cent. heat unit; J is given as 778 foot-pounds. But the Centigrade system is employed throughout almost the whole of the book. On p. 26 the symbols M and *m* conflict; M appears in the text and *m* in the equation. On p. 69 we read the loose statement that "1 cubic foot of petrol would require for complete combustion . . . 45·41 cub. feet of air"; and on the same page: "The volume of the exhaust product . . . is 14·75 lbs." On p. 186 work is measured in "feet-lbs.," and elsewhere in "foot-lbs."

There are no exercises for the student to attempt for himself, but there are a few worked-out examples in the text. The book, however, contains a collection of matter which cannot fail to be of service to anyone studying problems connected with the changes occurring inside the cylinder of internal-combustion engines.

## 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.*]

### A Very Penetrating Radiation in the Atmosphere.

IT is noteworthy that English physicists have taken very little interest in the progress which has been made during the last ten years in atmospheric electricity. This is the more remarkable seeing that some of the problems are problems in pure physics, and there is little doubt that they give evidence of phenomena of fundamental importance. To take one or two examples. There can now be no doubt that the earth is giving off a constant stream of negative electricity which passes at least into the upper atmosphere, and probably into cosmical space. Are we justified in treating this result of innumerable observations in all parts of the world as something which will be explained in due time by the old laws of physics, or should we not recognise the possibility that we have here indications of a new property of matter? The earth is a huge insulated mass of matter moving unrestrained under cosmical forces, and therefore may very well reveal a relationship between electricity and the motion of matter to which laboratory experiments could give no clue. This phenomenon is well worth the consideration of the mathematical physicists who are at present throwing all our preconceived ideas of electricity, mass, motion, and gravity into the melting-pot.

Then, again, it is now no longer possible to treat ball lightning as a figment of the imagination caused by the bewilderment due to a near lightning flash. What are these balls of light which travel and react according to no laws of physics at present known?

The results of Vegard's and Störmer's work on the aurora are probably too new to have attracted widespread notice, but here we have indications of true radio-active radiation penetrating our atmosphere and producing the same apparent results as if the atmosphere were being bombarded from outside by the $\alpha$ radiation which is at present under investigation in our laboratories.

The object of this note is to direct attention to another phenomenon of atmospheric electricity which is of first-rate physical importance.

Until quite recently the most penetrating radiation capable of ionising gases of which we have knowledge is the $\gamma$ radiation emitted by radio-active substances. Balloon ascents, however, made in Germany just before the outbreak of war have given almost incontestable proof of a radiation entering the atmosphere from above which has ten times the penetrating power of the hardest radiation sent out from radio-active substances. The method of experiment is to carry up in a balloon a metal box of 3 mm. thick brass coated on the inside with zinc and hermetically sealed. The ionisation within the box is tested at each height by means of a central electrode connected to a Wulf electroscope. It is found that the ionisation within such a box decreases at first after leaving the ground and then returns to its original value at about 1500 metres altitude, after which it increases rapidly to the greatest height reached. The most perfect set of observations was made by Kolhörster in June, 1914; the most perfect in the sense that his apparatus had had all the defects removed which previous ascents had revealed, and the greatest height of any ascent was reached. The results are shown in the following table, in which $q$ is the number of pairs of ions generated (cm.$^{-3}$ sec.$^{-1}$) in excess of those generated in the same box on the ground:—

| Height km. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| $q$ | 0 | −1·5 | 1·2 | 4·3 | 9·3 | 17·2 | 28·7 | 44·2 | 61·3 | 80·4 |

The decrease in the first kilometre is due to the cutting off of the penetrating radiation from the radio-active contents of the ground by the lower layers of the atmosphere. The great increase in the ionisation from 2 km. to 9 km. is clearly shown.

The war has naturally put an end to further observations in balloons, but not to the search for the origin of this amazing radiation.

In a paper published in the Elster and Geitel *Festschrift*, E. v. Schweidler discusses several possible sources of the radiation, only to reject them all. He first calculates the absorption coefficient of the new radiation, assuming that it is penetrating vertically downwards through the atmosphere, and finds $\mu=7{\cdot}46\times10^{-6}$ cm.$^{-1}$ and $\mu/D=5{\cdot}77\times10^{-3}$ cm.$^2$/gram (the corresponding values for $\gamma$ radiation from radium being given by Rutherford as $6{\cdot}0\times10^{-5}$ cm.$^{-1}$ and $4{\cdot}6\times10^{-2}$ cm.$^2$/gram respectively). Applying these values to the observations, he finds that on the confines of the atmosphere 535 ions (cm.$^{-3}$ sec.$^{-1}$) would be generated in air at standard density. Assuming, then, that the radiation is similar to that sent out by radio-active substances, he calculates that if all the new radiation came from the sun the latter would have to possess a specific activity 170 times as great as that of pure uranium. This he considers to be a quite impossible value.

Schweidler then considers the possibility of the radiation being due to a radio-active gas in the atmosphere, and shows that if the gas obeys Dalton's law, the rate of increase of $q$ with height would be entirely out of agreement with the observed values.

The only hypothesis considered by Schweidler which is not entirely out of agreement with the observations is that cosmical space is filled with a radio-active gas. The calculation shows that, strange as it may seem, the radiation would be independent of the density of the gas, which would only need to have a specific activity 1/1200 of that of uranium to provide the observed ionisation. Needless to state, Schweidler does not favour this latter explanation.

In the *Meteorologische Zeitschrift* for April, 1916, Linke attempts to solve the same problem. He shows that the observations fit in very well with the ionisation which would be produced by a layer of radio-active substance spread uniformly throughout the atmosphere at a height of 20 km. In this case the rays would not penetrate only vertically downwards, but in all directions. This alters the coefficient of absorption from $\mu=7{\cdot}46\times10^{-6}$ cm.$^{-1}$, as calculated by Kolhörster, to $4{\cdot}6\times10^{-6}$, as calculated by Linke.

Linke concludes that there is a layer of cosmical dust in the stratosphere, which is strongly radio-active, and supports it by the following considerations:—

(*a*) The presence of dust in the stratosphere is clearly shown by several optical effects—for example, twilight phenomena and Bishop's rings.

(*b*) Dust which is present in the stratosphere cannot fall into the troposphere except with great difficulty, owing to the temperature inversion, which is a well-known trap for dust.

(*c*) There was a considerable increase of this dust after the earth had passed through the comet's tail in May, 1910.

(*d*) On this occasion Thomson, in America, observed a sudden increase in the penetrating radiation measured near the ground.

Many more observations are necessary before Linke's hypothesis can be accepted, so it is no use considering it in further detail. For physicists, however, the most interesting fact is that these observations leave little doubt of the existence of a new extremely penetrating radiation, which increases as one ascends in the atmosphere.

G. C. SIMPSON.

## Airplanes and Atmospheric Gustiness.

IN a recent discussion of the action of an airplane encountering gusts, it is stated that a velocity of about six metres per second may be regarded as a mild gust. Making use of an exponential equation and starting from a condition of still air, increasing to a certain intensity, the value of the exponent is taken as determining the sharpness of the gust. With a value of 1, the gust reaches nearly its maximum value in one second, which would be a decidedly sharp gust.

It is evident from the discussion that data for the natural conditions are meagre; in fact, it seems plain that the engineers have entirely underestimated the velocities likely to be met with in the free air at low altitudes. And gusts do not as a rule begin from a still condition. Moreover, since the flow of the air may be upward, downward, inclined, or on the level, straight or rotary and superimposed on steady or intermittent general motion, it will be difficult to express in a general formula the condition of flow in a gust; and possibly no two gusts will be alike.

The problem of the stability of an airplane in a gusty atmosphere belongs without doubt to the aeronautical engineer; but there is another problem, that of systematically recording the general character of the air flow with regard to gustiness, which belongs to the aerographer; and it will be readily conceded that this latter problem is now one of some moment. The question is then, How shall gustiness be recorded in the various observatories of the world?

We are attempting at Blue Hill to record each day the number of hours during which aviation is considered safe and unsafe. Our method is doubtless crude, for we use the wind velocities indicated on an anemo-kinemograph, counting as safe those hours during which the average velocity does not exceed 10 m./s., and there is no variation greater than 50 per cent. in five minutes. For example, the records of March 2 and 5 (not reproduced here) illustrate days on which respectively there were 24 and 0 hours suitable for aviation. Incidentally we have been able with another instrument to obtain records showing a variability of 50 per cent. in three seconds; also velocities as high as 60 metres per second; and one true gust in which the total air flow was 370 metres in ten seconds, of which 300 metres occurred in five seconds.

Since we have no International Committee—and let it be said, not in bitterness, but sadness, that it is quite unlikely that representatives of certain nations will be welcomed at any international conference for years to come—there is no way now open to reach an agreement unless the British Meteorological Office will be willing to formulate a definition. Under its progressive director it has become the leading and representative Service, and one the methods of which will be generally accepted.

This particular feature of the weather has not heretofore received much notice, other than the recording of days on which gales occurred; but it is evident now that a more detailed record of the condition known as gustiness must be kept.

Perhaps some of the readers of NATURE can offer suggestions?

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## THE BEDROCK OF EDUCATIONAL PROGRESS.

THE final Report of the Departmental Committee on Juvenile Education in Relation to Employment after the War, a summary of the recommendations of which appeared in our issue of last week, is a welcome indication of the great change which within the last few years, and notably during the course of the present disastrous war, has come over the mind of the nation in respect of the importance and necessity of increased facilities for education for all classes of the people and the need for a more intelligent and generous estimation of its requirements.

The committee, in entering upon the inquiry, set before itself a high ideal, realising, as the report shows, the great work of reconstruction which the war has imposed upon the nation in many spheres of its activities—social, industrial, and commercial—in the successful accomplishment of which it boldly asserts that "education, with its stimulus and discipline, must be our stand-by." The committee has taken full advantage of the terms of reference to review the conditions under which elementary education is administered in England and Wales, its range, quality, and purpose, especially in the later years of school life, and to lay bare in the report its shortcomings, no less than the grievous waste of the public resources arising from the ineffective preparation of the great mass of the children of the nation for the duties and responsibilities of life and for a satisfactory livelihood, due to the fact that so many of them are allowed to leave school at an untimely age and that no proper provision is made for the continuance of their education on entering into employment.

The war, by the shutting down of commerce with the Central Powers, has revealed to all classes of the community the vast extent to which we were dependent upon them, and especially upon Germany, for the supply of many highly valuable manufactured products, essential to our well-being, and the fruit solely of the applications of scientific discovery: that she held the "key" to certain of our important industries, such, for example, as those of cotton and woollen textiles, which largely depended for their successful marketing upon the dyes and finishes manufactured by German chemical firms. Hence the grave uneasiness which has of late possessed the minds of many of our leaders as to the state of our education, and as to the results of the large and growing expenditure upon it since the Act of 1870, and now amounting, imperially and locally, to considerably more than thirty millions sterling annually.

It is recognised, and it is a highly commendable feature in the report, that elementary education is the base of any effective educational organisation, and that the superstructure of secondary and university education rests of necessity upon it, so far as the means of selection of the best brains of the mass of the nation for the opportunity of advanced training is concerned. The first demand must therefore necessarily be that the course of elementary education shall be continued without any exemption whatsoever for every child up to the age of fourteen at least. The report shows a leakage in full-time attendance at the elementary school of at least 33 per cent. between twelve and thirteen, and thirteen and fourteen years, at least in the period before the war, whilst for the years beyond and up to the age of eighteen the number of young persons outside all vital educational influences reached the astounding number of 2,200,000, or 81·5 per cent. of the total number of juveniles at these ages. This vast number of young people are to be found neither in day nor in evening schools, and to them must be added the large number of half-timers who, chiefly in the textile districts, are receiving a scanty education, under "the present detestable system of half-time exemptions," between the ages of twelve and thirteen.

With this mass of meagrely educated and ineffectively trained young people physically, mentally, and morally, how is it possible to maintain the position of this nation, with its enormous imperial responsibilities, in face of the social, industrial, and commercial competition of the better instructed and trained nations of the Continent, whose recognition of the potentialities of science and the assiduity and the complete preparation with which they have pursued it have enabled the greatest of them, namely, Germany, to become our most formidable rival? Despite the warnings so strikingly set forth in the report of the Royal Commission on Technical Instruction of 1882–84, and of all the efforts which ensued thereon to establish throughout the kingdom technical schools and classes, only a mere fraction of the industrial population has been reached, and because of the inadequate preparation of the large majority of the students who availed themselves of the facilities offered, which were chiefly in the evening, at the close of the day's work, only a comparative few reaped the full benefit of the provision made.

The truth is that we began at the wrong end, and we now realise in some measure the serious character of our error. We failed to perceive that no satisfactory technical instruction can be given except upon a sound basis of general, including scientific, training, continued throughout the full period of pre-adolescent life, and that such training for those capable of receiving it—and they are a considerable percentage of the general mass—shall be further continued for whole-time pupils in suitably equipped and staffed secondary schools, in preparation for the highest specialised instruction and training available in our universities and in the highest type of technological institutions.

For those who must perforce—and they will be the great majority of those attending the elementary schools—enter the ranks of bread-winners on leaving school at fourteen, the report makes a strong plea for provision for continued education for at least eight hours per week, taken from the ordinary working hours and continued for ten months during each year until the age of eighteen is reached. The course of education to be pursued in these compulsory classes would have reference to preparation for the duties of life, to the right and profitable use of leisure, to instruction in the principles and practice of the occupation into which the young person had entered, and to the care and preservation of bodily health and vigour. To achieve this aim is a national duty of tremendous—of paramount—importance, and, having regard to the vast depletion of our young virile life by the operations of the fierce struggle in which we are engaged, of stern, unyielding necessity, no matter how great the cost, if the future of the nation is to be assured as one of the great civilising and freedom-inspiring forces of mankind. The task of the nation is enormous. It can only be accomplished by a spirit of stern self-sacrifice.

Readers of NATURE will not need to be reminded that the findings of this—it is to be hoped, epoch-making—report are consistent with its constant advocacy through many years of the policy of raising the school age, and of requiring regular attendance until the compulsory period of elementary-school training is completed, of due provision in the curriculum for satisfactory training in the facts and principles of science, and of continued compulsory education until eighteen years of age is reached of all young people entering employment at fourteen years of age It is also not out of place to remark that so long ago as 1914, before the advent of the war, the Education and Technical Education Committees of the British Science Guild had prepared a report embodying the main points of the report now under review, and this has since been presented to the Prime Minister's Reconstruction Committee for consideration in connection with schemes of educational reconstruction. The Departmental Committee on Juvenile Education has had the advantage of interviewing witnesses representative of many varied industries, including both employers and employed, together with persons representing the opinions of various educational bodies, and has found, speaking generally, a practical unanimity of opinion in the reforms set forth in the report; it is satisfactory also to find that the report and its recommendations are signed by all the members of the committee. It is to be hoped that the principal recommendations may quickly be given legislative effect.

## *SCIENTIFIC ASPECTS OF GLASSHOUSE CULTIVATION.*[1]

THE valley of the River Lea is the seat of some of the most intensive cultivation in the British Isles. The traveller along the Great Eastern Railway line to Cambridge, which traverses this district, begins to see great numbers of glasshouses soon after leaving Enfield, and still more near Enfield Lock, Waltham Cross, and Cheshunt. It is estimated that in this district there are no fewer than 1000 acres occupied by glasshouses, each acre representing a capital of approximately 1000*l*. The chief crops grown are cucumbers and tomatoes, but peaches, grapes, roses, palms, and other plants are also produced. The growers, as might be expected, are extraordinarily skilful: one sends peaches to New York in the proper season at fancy prices; another has even sent palms to Africa; but the great bulk of the produce is grown for the English consumer, and is put on the market at such prices as are within the reach of all.

As might be expected, glasshouse cultivation presents special features marking it off sharply from outdoor work. The temperature and water supply, perhaps the commonest limiting factors on good farms, are under almost complete control, and can therefore be eliminated as limiting factors; but the light supply is often an important factor, while questions of manuring, the adjustment of temperature, and water supply are of enormous technical importance and great scientific interest. In addition, the special conditions lead to some remarkable soil relationships.

Some of these problems were first studied three or four years ago at the Rothamsted Experimental Station, but it soon became clear that the only proper way of dealing with them was to found an experimental station *ad hoc* and to place it in the centre of the district. This was done, the money being found partly by the growers and the county councils, and partly by the Development Commission. The second annual report of the new station is now issued.

It is pointed out in the report that the investigations at the Experimental and Research Station must not follow too closely the lines adopted at the agricultural experiment stations, but must differ from them in taking more account of the qualitative factors which might affect the fruiting, and in recognising light, temperature, and water as factors influencing the growth and habit of the plants. For convenience of investigation the plant-growth is divided into three stages: the early stage, as seedlings and in small pots; the later stages in large pots or borders; and the fruiting stage. This division is justified not only on technical, but also on scientific, grounds.

In the first stage—the seedling stage—probably the most important feature is the type of growth. Growers recognise a "hard" growth and a "soft" sappy growth, the latter being commonly considered of less value for fruit production. The conditions under which each can be got are well known to the grower, but it is very desirable that they should be better characterised than they are at present, and that the relationship between habit and conditions of growth should be studied. The habit of growth owes its importance to the two circumstances that "soft" growth appears to be more susceptible to disease than "hard" growth, and that under certain conditions it is less conducive to fruiting. There are certain discrepancies in the observations so far, arising from the variations in the type of "softness," and these are being studied.

[1] Experimental and Research Station, Nursery and Market Garden Industries Development Society, Turner's Hill, Cheshunt, Herts. Second Annual Report, 1916.

In the later growing and fruiting stages the influence of fertilisers is under investigation, and also the effect of light, temperature, humidity, and other physiological factors. None of the artificial fertilisers produced any notable effect on the tomato crop; the withholding of phosphates caused some depression, but the withholding of nitrogen and potash had little, if any, effect. It must be remembered that the soil is virgin soil, and the results seem to be on a par with the old antagonism between vegetative growth and fruiting. Mr. Spencer Pickering obtained very similar results at Woburn in his manurial experiments with fruit trees and bushes. The result is contrary to the usual experience, and indicates that a marked distinction must be made between virgin soils and soils that have been in use for some time. The reason for the distinction, however, is not clear.

In the case of cucumbers, phosphates in some circumstances actually depressed the crop, as has been noted elsewhere with cotton and sugar-cane. The determining factor in the case of cucumbers under the conditions of the experiment was the temperature, and the experiments show in a striking way how easy it is for the leaves to become overheated in a glasshouse—a phenomenon already discussed by Francis Darwin. The cooler part of the cucumber-house gave in the first year 25, and last year 9, per cent. more fruit than the warmer part. Proper appliances have been installed for the study of this important problem, and the results will be awaited with much interest. E. J. R.

## THE NEW FOOD ORDERS.

THE reduction of the available supply of certain articles of diet, especially of meat, flour, sugar, and potatoes, has had the effect of changing to some extent the point of view with regard to economy in diet. While until recently economy in all things was desirable, it has now become necessary to exercise, in addition, special economy in the case of the four things mentioned above. This is due partly to deficiency in means of transport, but, in the case of potatoes, chiefly to bad crops. It must also be remembered that the large proportion of the population serving in the Army or Navy require more than they had in their previous occupations. For these reasons, it has been recommended by some that those who are well-to-do should endeavour to utilise the more costly articles of food, leaving a greater supply of the less costly, but restricted, articles for those who cannot afford the former. With regard to the Army rations, there is some reason to suppose that the allowance of 16 oz. of meat per day is unnecessarily large, at all events for men in the trenches; perhaps it may be the cause of certain diseases which are apt to occur, such as "trench nephritis." This affection seems to have some relation to diet. The meat allowance might, with advantage, and probably with appreciation by the men, be exchanged for an equal energy-value in carbohydrate.

The new arrangement of rationing by bulk, as applied to restaurants, is undoubtedly an advance. As the present writer has pointed out in another place, the old system of limiting the number of courses led to an undesirable increase in the consumption of meat, as compared with other foods. The present allowance of 12 oz. of meat per day gives about 70 grams of protein, in addition to that in bread and other articles—a perfectly adequate supply. It is, however, not quite clear why households should be allowed only about 6 oz. per head. In some cases, no doubt, the smaller consumption by children compensates. But it must always be kept in mind that children require more protein in proportion to their weight than adults, since they are forming new body-tissues, and it is only up to a certain age that children require absolutely less protein than adults. It would probably be correct to say that quite half the total number of households consist of persons requiring the protein ration of adults. Of course, meat is not the only source of protein; oatmeal especially is an excellent source, and, at present, the necessary energy-value can be made up with this, at the same time as the increase in protein.

With regard to the materials to be added to wheat-flour, would it not be better to limit them to those not readily used by themselves, such as barley and rye? Beans, especially, seem to the writer an undesirable constituent of bread. If oatmeal, for example, is to be used in large quantities for mixing with wheat-flour, is it not probable that the price will rise considerably?

The new Order with respect to hoarding of food is rather difficult to understand. Presumably, it is not intended to prevent the purchase of fairly large amounts at a time, provided that these amounts are made to last as long as if bought in small parcels; nor to prevent the storage of sugar for the purpose of making jam by the householder in the autumn. W. M. BAYLISS.

## A MINISTRY OF HEALTH.

WITH the terrible wastage of the lives of the best of the nation's manhood in the European conflict, and with a birth-rate the lowest on record, if the country is to recover after the termination of the war and to maintain its place among the nations as a great and thriving industrial Power, it will be necessary for us to conserve to the utmost those lives which we possess and those which we may expect to be born to us. While it may not be practicable at present to anticipate a definite increase in the birth-rate, though it is to be hoped there will before long be a change for the better, it is possible to do much to reduce disability and loss of life from preventable disease. The campaign against venereal disease, the crusade against tuberculosis, the care now being taken of munition and other workers, and the medical consultations at infant welfare centres and at school clinics all aim at this and are valuable aids towards its consummation.

The most serious item of loss of life is, and always has been, infant and child mortality. For the years 1911-1914, 575,078 children died under the age of five years in England and Wales. It is true that infant and child mortality has declined during the last few years, but, even so, we are losing 100,000 lives or more annually, a large proportion of which could undoubtedly be saved to stock the country in the future. A broad and comprehensive scheme of national health service would accomplish much, and this is a problem to which the best energies of the Government should be directed without delay.

There is reason to believe that the Bill dealing with health questions which it is the intention of Lord Rhondda, the President of the Local Government Board, to introduce, will provide for the creation of a Ministry of Health, in which the supervision of many of the public health and medical services of the country will be concentrated. At present the national health is dealt with by several Government Departments—it is stated, by as many as *fourteen!* Thus, the general public health is administered by the Local Government Board, the health of workers by the Home Office, the health of school children by the Board of Education, the health of ships by the Board of Trade; and the Board of Agriculture, the National Insurance Committee, and other Departments share in various ways. Such a multiplicity of authorities naturally leads to much overlapping, want of co-ordination, and waste.

The establishment of a Ministry of Health, with a Minister of Cabinet rank in charge of it, which would bring under its ægis the whole of the health service and administration of the country, would be a measure of the highest importance at the present time. Wisely conceived and wisely administered, such a Ministry would be welcomed by the medical profession and by health workers generally, the public would gain by increased efficiency and diminished waste, and the national health would be placed on a surer foundation of control than is at present the case.

## NOTES.

WE are informed that the South-Eastern Union of Scientific Societies will hold its twenty-second annual congress in the rooms of the Linnean Society, Burlington House, from Wednesday, June 6, to Saturday, June 9, under the presidency of Dr. W. Martin. Arrangements will be facilitated if those proposing to join the congress will communicate with the hon. treasurer, Mr. R. Adkin, 4 Lingards Road, Lewisham, S.E. The Wednesday evening will be devoted to the president's address, and on the Thursday evening the attendance of the congress at the "Hooker lecture" by Prof. F. O. Bower will be invited by the Linnean Society. The union may be congratulated on maintaining its accustomed course at a time when the claims of science are being brought prominently before the public mind.

WE learn from *Science* that the Academy of Natural Sciences of Philadelphia has, on the recommendation of the council and the special committee on the award, voted the gold Hayden memorial geological medal to Prof. W. M. Davis, emeritus professor of geology in Harvard University, in recognition of his distinguished work in the science of geology. The medal, says *Science,* is awarded every third year "for the best publication, exploration, discovery, or research in the sciences of geology and palæontology, or in such particular branches thereof as may be designated." The award as first defined in 1888 took the form of an annual bronze medal and the balance of the income of the fund. The deed of gift was modified in 1900 so as to provide for a gold medal every third year.

DR. J. O. HESSE, director of the Associated Quinine Factories of Zimmer and Co., died at Feuerbach, near Stuttgart, on February 10, in his eighty-second year. Dr. Hesse devoted almost the whole of his scientific career to the extraction and examination of the active constituents of drugs, particularly of cinchona bark, coca leaves, and opium, and was for many years the leading authority on the chemistry of quinine and other cinchona alkaloids. He isolated physostigmine from Calabar beans, cotoin, paracotoin, and other principles from coto and paracoto barks, ditaine from dita bark, and also the active principles from a number of other drugs. Many of his researches were published in the Journal of the Pharmaceutical Society, of which he was elected honorary member in 1879. The value of his original investigations gained for him in 1891 the Hanbury gold medal, the highest honour that the Pharmaceutical Society can bestow.

THE death is announced of Mr. Arthur Brooker, joint-author of Slingo and Brooker's "Electrical Engineering" and of other works. From the *Electrician* we learn that Mr. Brooker joined the telegraph department of the Post Office Service in 1878. In 1889 he became an instructor in the Telegraphists' School of Science in mathematics and laboratory practice, and the following year he was made chief instructor. He was also on the staff of the People's Palace and the Currie School of Engineering as instructor in electrical engineering. His scientific attainments procured for him rapid promotion in the Post Office Service. He was largely responsible for the development of the present testing branch. It was his association in the production of Slingo and Brooker's "Electrical Engineering" in 1890 which brought his name before the public. After the publication of the book the authors entered into journalism, and contributed largely to the pages of the *Electrical Review.* In 1898 Brooker severed his connection with the Post Office, and became works manager of the Peel works of the General Electric Co., where he spent seven years in organising the factory and devoting himself to the manufacture of telegraph and telephone apparatus. In 1906 he joined the British Insulated and Helsby Cables, Ltd., and on the formation of the Automatic Telephone Manufacturing Co. in 1912 he became its general manager, a position he retained until shortly before his death.

THE March number of the *Scientific Monthly* contains a series of articles by well-known American authorities on the question of the metric system of weights and measures. During the last sixteen years the movement for the compulsory adoption of the metric system in the United States has made considerable progress, thanks, in great measure, to the stimulus given by the Bureau of Standards at Washington. The enormous quantity of war material at present being manufactured to metric sizes in America is rendering the workmen as familiar with grams and centimetres as they are with the pound and foot. It is felt in many quarters that the present time affords an unusual opportunity for making metric weights and measures the official system of the United States. The allegation of the opponents of the system that its general introduction would render obsolete and useless large quantities of machinery and machine tools is being vigorously combated, and it is being made clear to manufacturers that no ordinary machines, such as lathes, drills, shapers, etc., would have to be changed. The same tools would continue to make the same things, but the numerical values of the sizes made would be altered. Much attention has been given to the question whether the expense and inconvenience necessarily incident to the exclusive use of the new system would be too costly, and it is generally conceded that these would be far outweighed by the national and international advantages accruing from the change. It is not proposed that a sudden transition from one system to the other should be sanctioned by Congress, but that ample time for preparation should be allowed. In this way price lists, catalogues, and sizes could be tabulated in advance in both systems, side by side, so that the old numerical values could gradually be dropped.

AT the end of July last year, at the instance of the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, a meeting of representatives of some of the larger firms engaged in the various branches of the cotton trade and others interested in textile research was called by the Lord Mayor of Manchester to consider the possibility of establishing a scheme for the scientific investigation of the various problems presented by the cotton-using industries, and it was agreed that there is great need for research bearing on the cultivation and manufacture of cotton, and in the dyeing, printing, bleaching, and other finishing processes. It was also thought that efforts should be made to increase and to improve the system of textile education. A provisional committee was afterwards appointed, and this, in due course, was constituted a committee of the Advisory Council of the recently formed Government Department of Scientific and Industrial Research. This committee is largely representative of the various interests concerned. Its function is to formulate a preliminary scheme of a comprehensive character and to report to the Advisory Council, and then to lay before the trade, for its consideration, definite proposals for the establishment of a research association, eligible for recognition by the Government Department, and consequently for monetary grants from the National Exchequer. The committee has to consider the place for research in each branch of the cotton industry, whether in the cultivation of cotton, in spinning, doubling, manufacturing, knitting, lace-making, bleaching, dyeing, printing, finishing, or in the technology of cellulose. It has also to ascertain what facilities now exist for the education of boys entering any of these branches, and what opportunities are likely to be offered by the trade for the employment of highly trained men. It will also formulate a scheme, both for an institute to undertake research work in collaboration, so far as practicable, with existing bodies and for an association of firms and individuals willing to make donations and subscribe regularly for a period of years to promote research and improve technical training Any suggestions relating to the researches to be undertaken, or to any other matters coming within the scope of the proposed association, will be welcomed by the committee, and should be sent to the secretary, Provisional Committee on Cotton Research, 108 Deansgate, Manchester.

IN the *Archives of Radiology and Electrotherapy* for March (No. 200) Mr. Hector Colwell gives a second instalment on the history of electrotherapy, in which the contributions of Priestley, Jallabert, Galvani, Volta, Aldini, Duchenne, and Marat are described. It is of interest that Marat, the French revolutionary, was a practitioner of electrotherapy. Articles on methods of jaw radiography and on abscess in bone are also included in this interesting number.

A SECOND report upon investigations in the United Kingdom of dysentery cases received from the eastern Mediterranean has been issued by the Medical Research Committee. In this report (No. 2) Drs. Rajchman and Western discuss the findings in 878 cases of bacillary enteritis. Serological evidence of bacillary dysentery was obtained in 34·7 per cent. of the cases examined, of paratyphoid infection in 18·3 per cent., of mixed dysenteric and paratyphoid infections in 10·1 per cent., and of pure amœbic infection in 6·2 per cent. In every case of mixed bacterial infection, dysentery bacilli were the originally infecting virus, and a considerable number of purely bacillary cases of dysentery were detected. While not wishing to minimise in any way the amœbic factor, Drs. Rajchman and Western hold that the Mediterranean infection was essentially a mixed one.

THE Journal of the South African Ornithologists' Union for December, 1916, has just reached us. In his observations on the birds of the district of Humansdorp, Cape Province, Mr. B. A. Masterman remarks that Kolb's vulture "has entirely disappeared from that area, not one having been recorded for the last fifteen years," where formerly it used to breed regularly. According to the farmers, this bird was exterminated from having feasted on the flesh of cattle which died of rinderpest during the great outbreak of that disease. The late Capt. Selous, it may be remembered, commented on the absence of vultures of this species from the battlefields in Rhodesia during the Matabele campaign, and attributed it to the same cause. In the same issue the Rev. R. Godfrey has some interesting notes on the summer migration of 1915–16 as observed in the eastern districts of the Cape Province.

A MOST admirable "Guide to the British Freshwater Fishes," by Mr. C. T. Regan, has just been issued by the trustees of the British Museum of Natural History. In the case of each species described the author gives its distribution not only in our home waters, but also outside the area of these islands. An added interest and value are given to his pages in that, as occasion offers, he provides evidence, from the distribution of our fish fauna of to-day, of a remote connection between our river systems and those of the Continent. His account of the Salmonidæ and of the various hybrid forms which occur so frequently among the Cyprinidæ will be especially welcome. An immense amount of information has been crowded into a very small space, yet nowhere has the reader cause to complain of a lack of interest or lucidity. Finally, the book is most profusely illustrated.

THE science of economic aviculture has probably reached a higher standard in the United States than in any other part of the world. This work is carried on by the Department of Agriculture, which, for years past, has spared no pains to enact laws and formulate schemes for the conservation of bird-life, whether for purely economic ends or for æsthetic reasons. As a consequence, it has now available a mass of evidence as to the status and value of every species within its realms. The latest evidence of its enlightened policy takes the form of a bulletin—No. 465—on the propagation of wild-duck foods. The haunts and food values of no fewer than nineteen groups of plants, comprising sixty species, are here described, together with instructions as to stocking water in need of bait for these valuable birds. The characteristics of wild rice, wild celery, pondweeds, arrow-heads, chufa, wild millet, and water-lilies are all carefully set forth, and this information is accompanied by carefully collected data as to their attractiveness in regard to particular species of wild ducks. Had we followed its lead years ago our own Board of Agriculture would now be able to speak with authority when called on to sift the value of the crudely formed opinions of local agricultural chambers as to the usefulness or otherwise of our native birds in relation to our food supply. The matter is of vital importance, and the clamour for legislation is sometimes insistent. This war has done much for us already; perhaps it may yet bring into being a bureau of ornithology, such as is to be found now in many Continental States, as well as in America.

THE new series of the *Agricultural Journal of India* which is inaugurated with vol. xii., part i. (January, 1917), contains several new features which should add to its value and interest. Selected short articles on a variety of subjects are included for the general reader, in addition to the original articles, which still remain the chief feature. A list of new books is also now added. Of the original articles a communication by Mr. and Mrs. Howard on leguminous crops in desert agriculture is of special interest.

BULLETIN No. 65 of the Agricultural Research Institute, Pusa, contains an account by J. N. Sen of experiments on the assimilation of nutrient materials by the rice plant at various stages of growth. Determinations were made of the nitrogen, phosphoric acid, and potash in the roots, stems, leaves, and ears of samples of a uniform crop taken at six successive stages of growth. The results form an interesting series, and lead to general conclusions which are in close accord with those obtained elsewhere with rice and other cereals grown under widely different conditions. It is of interest to note that no evidence was obtained of any return of phosphoric acid and potash to the soil, such as has been deduced from earlier German experiments.

IN Egyptian agriculture a very important *rôle* is played by the *berseem* crop (*Trifolium alexandrinum*), which covers nearly one-third of the cultivated area of Lower Egypt. The success with which it is grown in the low salt country in the extreme north of Egypt has suggested its use in similar country in India, and experiments have been in progress there on the Sukker and Mirpur Khas Government farms during the past ten years. A summary of the more recent results is given by G. S. Henderson in Bulletin No. 66 of the Agricultural Research Institute, Pusa. The results are uniformly favourable, and it would appear that the special merits of this crop as a cold-weather leguminous fodder crop that will grow in an alkali soil are likely to make it of the greatest value for wide tracts of land in the Government of Bombay and elsewhere in India.

THE Bulletin (No. 193) on calf-feeding experiments issued by Messrs. O. F. Hunziker and R. E. Caldwell, of the Purdue University Agricultural Experiment Station, is essentially technical in character, but contains a feature of general interest in the excellent methods adopted for securing photographic records of the progress in growth of the animals. In each case the animal was photographed on a narrow raised platform with a background divided into six-inch squares. A black or white background was used according to the colour of the calf. Difficulties might be expected in inducing the animals to take up a satisfactory position with relation to the background, but the photographs with which the bulletin is profusely illustrated indicate that these difficulties have been satisfactorily overcome, and the results certainly furnish the feeder with a much better index in regard to the condition of the animal than tabulated figures alone could give.

THE Geological Survey of Scotland, in the development of its national work, has published the first of a series of memoirs on "The Economic Geology of the Central Coalfield of Scotland" (1916, price 4*s.* 6*d.*). The district dealt with extends from Glasgow eastward to Salsburgh and Black Loch. The importance of marine zones as indicating horizons is pointed out, and maps are inserted showing by lines ("isopachytes") the thicknesses of selected seams in different parts of the areas which they underlie.

A NEW contribution to the problem of the clouds of vapour emitted by volcanoes is made by Mr. F. A. Perret in a paper on the eruption of Stromboli in 1915 (*Amer. Journ. Science,* vol. xlii., p. 462, 1916). The author observed that, without change in the conditions of eruption, a cloud was absent from the crater on a fine day, accompanied by a dry state of the air, but was copiously present when a chill moist wind supervened. A great cloud of vapour may thus be merely a condensation from the air on nuclei sent upwards by the volcano, and affords no indication of the condition of activity.

THE Geological Survey of New South Wales has published (1916) a "Bibliography of Australian Mineralogy," by Dr. C. Anderson, arranged under authors, States, and localities within each State. To find the reference to dundasite, for example, it is necessary to remember that it comes from Tasmania, or to look for it under each separate State. The completeness of the work is evidenced by the inclusion of Dr. Prior's paper, in which he compares this mineral with specimens from North Wales. Considerable selection, however, must have been exercised in dealing with references to Australian gold.

PROF. FILIPPO EREDIA, of the Italian Meteorological Service, has recently issued a manual of instruction in the use of meteorological instruments and for the taking of meteorological observations. The work in general get-up somewhat resembles the "Observer's Handbook" of our own Meteorological Office. A feature is the large number of illustrations, which are unusually clear and sharp. This manual of instructions has been brought out to normalise the work carried on at the widely spread network of stations in Italy and her colonies. We are surprised to find on Fig. 24 a representation of Six's thermometer, the defects of which are well known. Prof. Eredia has also sent an interesting pamphlet on the "Climate of Ghadámes," an oasis in the interior of Tripoli, 500 km. to the south of Tripoli, at a height of 340 m. above the sea. Ghadámes is in lat. 30° 8′ N., long. 7° 10′ W. The series of observations discussed comprise two sets, the first taken from the middle of August to December, 1861, while the second embraces the period June, 1913, to October, 1914. Dealing with the later series, the mean temperature, brought to a true average by comparison with Tripoli, is 23° C., the warmest month being August, with a mean of 33·8°, and the coldest January, with a mean of 11·1°. As compared with Tripoli, June is 9·2° warmer and December 2·6° colder. In the period under notice measurable rain fell on only five days, to the amount of 20 mm., and on fifteen others a few drops fell. The maximum fall noted was 8 mm. on February 14, 1914, with a N.W. wind. The cases of precipitation noted occurred principally with winds from the north-west and south-east. Winds are fairly evenly distributed round the compass, there being no marked excess from any one direction. In the year there were 251 cloudless and only twelve overcast days, the latter confined to the months November to March.

THE theory of the immobility of the ether is advanced by Prof. P Zeeman in a short article in *Scientia* for February (pp. 122–29). In addition to referring to the experiments of Fizeau and of Michelson and Morley, the author mentions a recent redetermination which he undertook in 1916, using monochromatic light. The results fully confirm Fresnel's formula, as completed with Lorentz's term, and the hypothesis of an immobile ether is in entire accord with the observed effects.

IN contributing a paper on "Impact in Three Dimensions" to the Proceedings of the Royal Irish Academy (xxxiii., Section A, No. 6), Prof. M. W. J. Fry has developed a subject on which a great deal evidently remained to be said over and above what is contained in Routh's "Rigid Dynamics." Some of the results are almost at variance with preconceived ideas on the subject. For example, while the velocity of compression can only vanish once in the two-dimensional problem, it may vanish three times in an impact in three-dimensional motion.

AN interesting note on the colouring matter of red torulæ, by Mr. A. C. Chapman, appears in the *Biochemical Journal* for December, 1916. Study of this colouring matter showed that it resembles carrotene in being practically insoluble in water, in dissolving to a blue solution in concentrated sulphuric acid, and in the fact that its chloroform solution, when warmed and exposed to the light, quickly becomes colourless. But comparison of the absorption spectrum of the torulæ colouring matter with that of carrotene showed that the two are by no means identical.

THE Journal of the Franklin Institute for March contains the address delivered before the institute in October last by Prof. L. V. King, of McGill University, on the acoustic efficiency of fog-signal machinery. After a review of the work on fog signalling done by the committee of the Trinity House in this country and by the lighthouse boards of the United States and of France, he describes his own measurements made in 1913 in connection with the fog-signal plant at Father Point, Quebec. The sound-producer there is a compressed-air siren of the Northey type using air at 25 lb. per square inch and giving a note of frequency 180 per second. During the actual emission of the sound 100 horse power is used. By measurement of the temperature of the issuing air when sound was produced and when not, it was found that only about 2·4 horse power was converted into sound. Tests of the intensity of the sound received at points on the water up to eight miles from the source were made by means of the sound-meter of Prof. A. G. Webster, of Clarke University, which depends on the motion of a small mirror mounted on a mica diaphragm at one end of a resonator. Zones of silence were found, on both sides of which the sound was distinctly heard. The existence of these zones appears to be intimately connected with the direction of the wind and to a less extent with the weather.

PROF. MARTIN KNUDSEN has recently described some interesting experiments on the condensation of metallic vapours on cold bodies (*Oversigt Kgl. Danske Vidensk. Selsk. Forh.*, 1916, No. 4, p. 303). When mercury vapour passes through a narrow opening into a large glass bulb containing a concentric smaller bulb tube with liquid air, most of the mercury vapour is condensed on the front of the smaller bulb facing the opening; a little passes alongside it on to the inner surface of the larger bulb, but no mercury is condensed on the back of the smaller bulb nor behind it on the larger one. The bulb with liquid air casts, as it were, a shadow, and retains all the molecules striking it. If, on the other hand, the inner bulb is only cooled with ether and carbon dioxide, the greater portion of the mercury vapour is not retained by it, and is condensed on the front half of the larger bulb. From the weight of mercury so condensed on the latter in an interval of time during which the inner bulb has only acquired a deposit thinner than the (known) limit of visibility, it is calculated that the chance of a mercury molecule being retained at its first impact on a glass surface at $-77·5°$ is less than 1 in 5000. Between this temperature and that of liquid air there is a critical temperature in the neighbourhood of $-140°$ to $-130°$. Preliminary experiments with a simpler apparatus indicate that for zinc, cadmium, and magnesium this critical temperature lies between $-183°$ and $-78°$, for copper between 350° and 575°, and for silver above 575°.

ALTHOUGH the principles that render colour kinematography possible are so simple, there appears to be an inexhaustible field for inventors in the applications of these principles, and not infrequently the details of "new" processes appear to the student of science as disadvantageous complications, if not actual infringements, of the necessary conditions. However, processes stand or fall by their results, and the *Scientific American* of March 10 states that the last "new process," as demonstrated at the American Museum of Natural History and the New York Academy of Sciences, seems to be "perfection." The simple attachments necessary can be fitted to any apparatus. A single film is used, and the pictures are taken behind a revolving four-sector colour filter, arranged with two pairs of complementary colours—namely, blue and orange, and blue-green and red. The complete element consists, therefore, of four consecutive pictures taken through colour filters in the order just named. The colour filter for projection has only two colours, red and blue, and has therefore to rotate at twice the rate of the filter disc used for taking the photographs. But each colour filter in the projector disc is subdivided into three sectors in such a way that each red and orange picture is projected through a red filter increasing in intensity in three stages, and each blue and blue-green picture in a similar way through three blue filters. The usual rate of projection is sixteen pictures per second, and Mr. G. A. Smith, in his "Kinemacolor," introduced in 1907, who used two consecutive colour pictures, found it necessary, as seems natural, to double this rate so as to maintain the same rate for each complete element. In the present case, with a quadruple element, one might expect the rate to be increased to four times—namely, sixty-four per second—but the actual rate stated is twenty-four—that is, only six complete elements per second.

## OUR ASTRONOMICAL COLUMN.

COMET 1917*a* (MELLISH).—Prof. Strömgren announces that from observations made on March 22, 23, and 24 (Copenhagen) Mrs. J. Braae and J. Fischer-Petersen have calculated the following orbit and ephemeris:—

$$T = 1917 \text{ April } 9{\cdot}4463 \text{ G.M.T.}$$

$$\left.\begin{aligned} \omega &= 106^\circ\ 51'{\cdot}66 \\ \Omega &= 92^\circ\ 47'{\cdot}32 \\ i &= 22^\circ\ 48'{\cdot}92 \end{aligned}\right\} 1917$$

$$\log q = 9{\cdot}41464$$

*Ephemeris: Greenwich Midnight.*

| 1917 | R.A. h. m. s. | Decl. ° ′ | Log *r* | Log Δ | Mag. |
|---|---|---|---|---|---|
| April 11 | 0 43 49 | +11 30·3 | 9·4295 | 9·8894 | 4·6 |
| 15 | 0 25 7 | 5 48·7 | 9·5156 | 9·9206 | 5·2 |
| 17 | 0 20 53 | 3 32·6 | 9·5672 | 9·9407 | 5·6 |
| 19 | 0 18 45 | +1 39·0 | 9·6172 | 9·9608 | 5·9 |

THE APRIL LYRIDS.—This shower of meteors, though occasionally offering a brilliant display, is, in the majority of years, very slightly visible. It is unfortunate that the period is not definitely known, though there are indications that its best returns occur at intervals of a little more than sixteen years. This feature is by no means supported on conclusive evidence, but it is a point worthy of further investigation.

Abundant showers of Lyrids were observed in 1803, 1851, 1884, and 1901, and it will be interesting to determine whether or not an unusual exhibition of these meteors is presented this year or in 1918. The time of maximum will possibly be at about midnight on April 21, and as there will be no moonlight to interfere, it will be easy to ascertain the character of the display should the weather prove suitable. If the meteors reappear at the time mentioned it will be important to observe the time of maximum and the horary number visible. The position of the radiant is already well known, and it moves eastwards, like that of the August Perseids. Though the chief activity of the Lyrids seems confined to a few hours, yet there are occasional specimens certainly seen between April 16 and 26, and possibly on dates still further removed from the night of maximum.

VARIABILITY OF URANUS.—Prof. E. C. Pickering has announced an interesting discovery which has followed from a series of photometric observations of the light of Uranus, made by Mr. Leon Campbell with the primary object of investigating possible changes in the light-emission of the sun (Harvard Circular, No. 200). The observations revealed a variation in the light of the planet amounting to about 0·15 magnitude in a period of 0·451 day, these figures being based upon 2960 settings. The period of variation agrees very closely with that of the rotation of the planet derived from spectroscopic observations by Lowell and Slipher, and Prof. Pickering concludes that the variation in light is due to unequal brightness of different portions of the planet. If the variations in brightness prove to be permanent, photometric observations will give the rotation period of the planet with a high degree of accuracy.

THE "ANNUAIRE ASTRONOMIQUE" FOR 1917.—The issue of this well-known publication for the current year contains the usual astronomical information in a convenient and interesting form, together with a review of the progress of astronomy. It forms a valuable work of reference for astronomical data of all kinds, including a catalogue of minor planets arranged in the order of their distances from the sun, a list of temporary stars which have been visible to the naked eye, a list of stars with large proper motions, and so on. Among the 140 illustrations we note a useful set of diagrams from which one can readily ascertain the visibility of each of the principal planets on any night of the year. M. Camille Flammarion is to be congratulated on having so successfully conducted this publication for more than half a century.

## HEAT ECONOMY IN METAL MELTING.

THE outstanding feature of the proceedings at the annual meeting of the Institute of Metals, held at Burlington House on March 21 and 22, was a general discussion on metal melting, organised by the council. Whether it was chiefly due to the fact that this subject aroused an unusual amount of interest among the members, or that war problems in metallurgy have created a desire to discuss those problems more freely than hitherto, the fact remains that in the last three months the institute has added more new members than it did in the previous two years; that the attendance was very much larger than it has ever been at any other meeting in the course of its history; and that the discussions on the various papers contributed were of unusual fullness and value.

Special appropriateness attached to the fact that Sir George Beilby, the president of the institute, in entering on his second year of office, presided over a discussion which must have been of considerable interest to him in his capacity of Director of the Fuel Research Board set up by the Committee of the Privy Council for Scientific and Industrial Research. Although coke constitutes the fuel most generally used in metal and alloy melting, only one paper was contributed dealing with its use. On the other hand, four papers were concerned with coal-gas, and these included one on the practice of the Royal Mint, and another on the application of the high-pressure gas system installed by the City of Birmingham Gas Committee. Of the remainder one paper dealt with producer gas, another with oil fuel, and a third with an electric resistance furnace. All these papers dealt with the melting of metals and alloys in crucibles, *i.e.* in quantities which seldom exceed 200 lb. in weight. The one paper on the subject dealing with principles rather than practice was by Dr. Carl Hering, an expert on furnace construction, and was entitled "Ideals and Limitations in the Melting of Non-Ferrous Metals." This, in many respects the most suitable for discussion, was not discussed by any of the speakers, and will be briefly commented on in this article.

Dr. Hering enumerates the directions to which perfection points as follows:—A reduction in (i) the loss of heat, (ii) the loss of metal, (iii) the number of bad castings, (iv) the consumption of equipment, and (v) the cost of labour and plant per lb. of good castings. As these are not all independent factors, economy may sometimes result from increasing some if others are thereby reduced more greatly, *e.g.* increased plant cost may save more in labour cost, and an increase in bad castings may even be warranted by the great saving of heat and labour due to working faster

With regard to heat losses, Dr. Hering points out that one of the first things to bear in mind in all high-temperature thermal operations is that insulation against heat loss is in practice at best very poor; that the ideal in this direction is the vacuum jacket of the Dewar thermos bottle, but that this, unfortunately, is impracticable for metal melting. Hence, so long as the metal is hot, just so long will this loss continue. Heat losses, however, depend not only on the thermal insulation, but quite as much also on the length of time during which they take place, so that reducing the duration of these losses reduces them in proportion. To obtain economy in heat, therefore, the ideal is not only to insulate as well as practicable, but also to heat and cast the metal in as short a time as possible, and this ideal may be approached by having each lb. of metal heated for the shortest possible time. *The total loss of heat per lb. of metal while it is hot is the criterion.* From this point of view Dr. Hering states that the ideally perfect melting furnace, if such it can be called, is the electric fuse, in which the intended result is completed in such an exceedingly short time —a fraction of a second—that the heat losses during that time are vanishingly small, and hence the thermal efficiency is practically 100 per cent.

With fuel heating, too great a rapidity of heating generally involves high chimney losses, *i.e.* a lower efficiency in heat transmission to the metal, and hence a limit to the speed is soon reached; but with electric heating there is no chimney loss, and the possibilities of rapid heating are therefore more encouraging. Electric arc heating involves high radiation losses from the arc itself, but in heating the metal by its own resistance the heat can be generated below the surface and in the metal itself, thereby eliminating all heat transmission losses. Extremely rapid heating then becomes possible, being limited only by the size of the heat-generating capacity provided, and in the case of brass or zinc by the volatilisation of the zinc in the part in which the heat is set free. By the resistance method, therefore, the ideal represented by the electric fuse can be approached more closely than by any other known method. Small high-speed furnaces are therefore, from this point of view, an approach to the ideal, particularly as they involve the minimum of contamination of the metal being melted. In Dr. Hering's opinion, it will in time become possible, for light castings at least, to be melted in an electric furnace about as fast as the metal can be cast, in which case the furnace would need to have a metal capacity of only enough for about two moulds. In that case it would be so small that it could be transported to the moulds, thereby saving the usual large heat losses in the transporting crucibles, besides the heat losses in the crucibles themselves.

Another factor, however, is involved, viz. the larger the amount of metal in a furnace, the less the *rate* of heat loss per lb., because the larger the volume, the less is the surface exposed. In a large furnace with a hemispherical hearth the heat loss per lb. of metal through walls having uniform insulation is reduced to about one-half when the capacity is increased from 1 to 10 tons. Hence, for this reason, the larger the furnace the better.

In choosing between these two apparently conflicting ideals the following considerations must be borne in mind:—(i) When melting is the only object, then the metal should be kept hot the shortest possible time; hence there should be used as small a furnace as is consistent with the amount of metal required for one casting. (ii) When there are involved operations such as refining, mixing, uniformity of alloying, the taking of specimens for analysis while melted, or any other process requiring time, the larger the furnace the better.

## LIQUID FUEL.

"LIQUID Fuel and its Combustion" was the title of a paper read by Prof. J. S. S. Brame, on February 20, before the Institution of Petroleum Technologists. Attention was directed to the increasing use of liquid fuel, and especially to its connection with those developments of the internal combustion engine which have so largely determined the progress of aviation and submarine navigation. Nevertheless he recalls the warning of Redwood (1905) that no oil supplies are in sight sufficient to replace anything like the bulk of solid fuel consumed. The use of liquid fuel for steam raising and industrial heating is the special subject of the paper, and the following considerations are brought forward. In constancy of chemical composition, whatever the source, and therefore of calorific value, mineral fuel oils compare very favourably with coal, and accordingly physical considerations such as low viscosity and freedom from grit may decide the choice of oil fuels. Turning to our home supplies, it is gratifying to note that the heavy fractions of the Scotch shale oils are ideal in this respect; having been distilled they are clean, while their fluidity is very satisfactory. Another home product, which is deserving of the close attention of liquid fuel experts, is coal-tar, the supply of which must increase with the extension of coal carbonisation. Its production may outgrow its uses in normal channels, and as a home-made liquid fuel its rational utilisation is a matter of high national importance. Nevertheless, for marine purposes tar (and tar oils) must remain inferior to petroleum, since a higher oxygen content and lower calorific value are inevitable, while a capacity for giving off disagreeable fumes may make it objectionable in the confined space of a stokehold. Methods of burning oil are surveyed historically, leading up to the spray burners now almost invariably used which "atomise" the oil.

The method of spraying is varied, depending on the use of compressed air or steam, or on forcing oil alone under pressure through a suitable burner, a method specially adapted for use in marine boilers. On theoretical grounds air injection would seem to be most generally efficient; steam may propel oil satisfactorily into the fire, but afterwards its influence on combustion can only be of negative value. The general arrangements of the system for combustion have more bearing on the success of a plant than the choice of atomiser. It is too often overlooked that, compared with solid fuel, where burning is mainly confined to the fuel bed, oils require a much greater volume of combustion space.

Looking to the future, Prof. Brame points out how much depends on the development of the internal combustion engine; for naval purposes he believes that oil firing with turbines will hold the field.

J. W. C.

## RECENT PROGRESS IN SPECTROSCOPY.[1]

### II.

RADIATION is an electromagnetic process, and must be determined by the electrical state of the radiator. A molecule may be neutral or for a moment charged by the loss or gain of an electron. This type of ionisation must actually occur, as indicated by the conduction of electricity through the vapour of a compound which shows no evidence of chemical dissociation. What causes the light emission? It may accompany the loss or gain of an electron by a neutral molecule, in which case the emission centre would be charged. It may be due to the shock of elastic collision with an electron or ion, or to the reunion of an electron with a positively charged molecule, in which cases the emission centre would be neutral. Luminous vapours emitting band spectra usually appear to be neutral at the instant of emission, so that it seems probable that band emission is due either to elastic shock or to the

[1] Address delivered to Section B—Physics—of the American Association for the Advancement of Science at the New York meeting, December, 1916, by the chairman of the Section, Prof. E. P. Lewis. Continued from p. 118.

recovery of a lost electron. It is to be remarked that as a rule band spectra are not subject to the Zeeman, Stark or Humphreys-Mohler effect; in the exceptional cases it is probable that those subject to one of these effects are subject to all. It would be of interest to examine these cases with reference to the nature of the molecular charge.

Luminous vapours emitting line spectra appear, in many cases at least, to be positively charged. A sodium flame is attracted to the negative plate of a condenser. A metallic salt introduced near the cathode of a spark discharge colours the spark only in that neighbourhood; if introduced near the anode, the colour flashes entirely across the spark. The most promising method of verifying such conclusions appears to be by the study of canal or positive rays. Sir Joseph Thomson, from a study of the deflections produced by magnetic and electric fields, found that, with very few exceptions, no molecules of either elements or compounds carry a negative charge, while those with positive charges are common. No molecule acquires more than one positive charge. The atoms of but few elements are found with a negative charge, but all may acquire positive charges and many may be multiply charged. For example, krypton may have as many as five and mercury eight positive charges. Hydrogen never has more than one charge, which accords with Bohr's view that it has but one detachable electron.

Stark has reached similar conclusions from a study of the spectra of canal rays. In many cases the motion in the line of sight gives a Doppler effect. There is an undisplaced line due to the stationary gas and a displaced line due to the canal rays. A distinct separation between the displaced and stationary lines shows that the canal rays cannot radiate until their kinetic energy reaches a threshold value, which Stark first interpreted in favour of the quantum theory, but which he now believes to represent the energy necessary for ionisation. There may be two or even three displaced lines, with separations consistent with the view that the luminous centres are doubly or triply charged. The radiation is evidently due to collisions, for a reduction of pressure in the canal ray chamber causes a reduction of luminosity. In general, all series lines are subject to the Doppler effect. Fulcher has shown that nitrogen canal rays give the negative pole band spectrum, with displacements, but no other bands have been found to give this effect. The series lines of hydrogen show displacements, but they are not observed in the many-line spectrum except to a slight extent in a few cases. Stark concludes that the series lines are emitted by positive atom ions, and the lines of the secondary spectrum by neutral atoms. He thus associates the compound spectrum with band spectra, which he supposes to be due to neutral systems. It may be remarked that Fabry and Buisson have concluded from measurements of the width of lines that both spectra are due to emission centres of atomic size. From a study of the displaced components of many elements, electronegative as well as electropositive, Stark concluded that in all cases line spectra are emitted by positively charged atoms. Aluminium atom ions may have one, two, or three charges, which appear in succession as the voltage is increased. The same is true of argon. The red spectrum is apparently due to singly charged ions, the blue or spark spectrum to multiple charges. Mercury may have as many as four charges, each giving rise to a characteristic group of lines, all those due to multiple charges being spark lines. From an examination of many such cases Stark concludes that in general arc lines or those of the positive column are due to singly charged ions, sharp spark lines to double charges, and diffuse spark lines to triple charges. There are some apparent exceptions to this classification, but in the main the evidence seems to support his views, which are also consistent with the results obtained by Reichenheim from the study of anode rays. For the first time we are thus enabled to assign a common cause for spark lines produced under apparently very different conditions. They are found in the spectra of disruptive discharges, of the negative glow in vacuum tubes; in the intermittent or oscillating arc when rapid changes in potential occur, although the maximum potential may be small; near the poles of the arc, where the anode and cathode potential gradients are steep; in the electric furnace when the temperature is high; in high temperature stars, and, as found by Hemsalech and de Watteville, even in the green cone of the Bunsen flame, where chemical action is energetic. In all these cases we might expect multiple ionisation to be favoured.

Similar conclusions regarding the charges of emission centres may be derived from observations by Stark, Child, Strutt, and others on the luminous vapours from an arc between charged condenser plates. The carriers of the line spectra are swept out of the field, while the luminous vapours giving band spectra are unaffected; or, if the lines of several series are present, their intensities are modified in different degrees by the electric field. Studies of the oscillatory spark by Schuster and Hemsalech, Schenck, Milner, Royds, and others indicate that the spark lines do not persist as long as arc lines. If the emission centres of the former are multiply charged this is what we might expect.

Investigations on the mechanism of the spark give results which at first sight seem opposed to Stark's theory. All observers agree that the luminous vapours appear to be projected from the cathode, with different velocities for different lines, and the tacit assumption seems to have been made that they are negatively charged. That metallic vapours are projected from the cathode is evident from the fact of cathode disintegration, and probably the particles are initially negatively charged. We know very little concerning this phenomenon, but two things are almost certain—that only a small fraction of the metallic particles take part in the luminosity, and that these particles are not negatively charged while radiating. The large velocities indicated by the curvature of the streamers viewed in a rotating mirror do not give rise to a corresponding Doppler effect, and it seems highly probable that Hull and Royds are correct in their surmise that what happens is really the propagation of a condition of luminosity through vapour which continuously fills the gap after the first discharge. Electrons initially projected with a high velocity, which diminishes as the field intensity drops to zero, and producing multiply charged ions in the beginning and singly charged ions towards the end of their course, would apparently account for all the observed effects.

While the experimental evidence seems to favour the idea that lines are emitted by positively charged centres, there is no *a priori* reason why neutral or even negative ions should not emit line spectra. It is quite possible that the canal ray lines which Stark attributes to singly charged ions may be emitted at the instant of neutralisation; but we cannot escape the conclusion that spark lines at least are emitted by positive ions unless we accept the improbable view that a multiple charge may be instantaneously entirely neutralised. Lenard inferred from the distribution of emission centres in the arc that the lines of the principal series are emitted by neutral atoms, those of subordinate series and spark lines by multiply charged atoms. Wien and others have suggested that line spectra may be emitted by molecules, but this seems improbable. On the other hand, we must admit the possibility of negatively charged centres which would probably exist only under exceptional conditions. Nicholson has, with success, assumed the existence of positive, neutral, and negative centres in accounting for the spectrum of the corona.

The fundamental importance of reaching definite conclusions as to the magnitude of the electric charge of emission centres is evident when we remember that any theory must take this into account. Bohr's theory rests upon the assumption that series lines are emitted by electrons previously detached as they return to equilibrium positions determined by the resultant charge of the system. In the case of hydrogen, if there be but one detachable electron, the radiating system must be neutral. If it can be shown without question that the emission centres of the Balmer series are positively charged, some modification of the theory seems necessary. Furthermore, if the centres are thus deprived of the one detachable electron, we must accept Stark's view that the series emission is due to electrons which cannot be detached. Fulcher has pointed out the necessity for a similar conclusion with respect to helium. Some of its lines are attributed to doubly charged atoms; but these are identical with alpha particles, the nuclei of the atoms, from which the radiation must be emitted.

Beyond the probable fact that band spectra are usually emitted by neutral systems, there is little evidence upon which we may rest a theory. Emission may accompany the neutralisation of a positively charged molecule by an electron or may be the result of internal vibrations due to collisions, without complete ionisation. Stark believes that the band emission is due to the detachable valency electrons, although the coupling between them and more firmly bound electrons may cause the latter to take part.

Evidence supporting Stark's views is to be found in absorption spectra. Hydrogen shows no absorption until it is ionised by a current. The cold vapours of the alkali metals and of mercury show line absorption, but their susceptibility to the photoelectric effect indicates how ionisation may be the prelude to absorption. All the corresponding emission lines appear to be due to singly charged emission centres. Absorption of the lines due to multiple charges does not take place until the vapour is highly ionised by electric discharges or high temperature. Substances which show band absorption under ordinary conditions, such as iodine, do not appear to be ionised when either emitting or absorbing. Both processes appear to be due to neutral systems. In such cases emission must be due to internal disturbances, without ionisation. The bands of some substances, such as nitrogen, are not found in absorption under any conditions, and the conditions of their occurrence indicate that the emission bands are due to the recombination of a detached electron with a positive molecule. The negative pole bands appear under the same conditions as spark lines, and it seems not improbable that they are due to the neutralisation of a doubly charged molecule.

The spectral differences attending different stages of ionisation are well illustrated by some recent experiments. Franck and Hertz found that mercury vapour is ionised by a field of 4·9 volts, and then emits the one ultra-violet line 2537. The Einstein relation $Ve=h\nu$ is fulfilled. McLennan and Henderson verified this conclusion, and also found that with a field of about 12 volts a second stage of ionisation occurs, attended by the emission of the many-lined spectrum attributed by Stark to multiple charges. McLennan finds that zinc, cadmium, and magnesium also give single line spectra which probably conform with Einstein's equation, which we should not expect to apply in a simple form to the many-line spectrum.

It appears from such experiments that there is a threshold value of kinetic energy which must be imparted to an emission centre before it can radiate, which represents the work of ionisation and is equal to a light quantum. Franck holds that this energy may be devoted either to ionisation or to emission, but that both cannot simultaneously occur. Stark believes that the two are coincident, the emission accompanying the rearrangement of electrons in the atom after one has been ejected. This suggests an explanation of quantum emission involving no departure from accepted electromagnetic theory.

The spectra of hydrogen and of helium are of particular interest because their atoms are of the simplest type and because it is possible that they are the basic units of which all elements are composed. The Pickering series in stellar spectra was attributed to hydrogen because of its numerical relationships with the Balmer series. The study of series relations led Rydberg to predict the occurrence of a principal series for hydrogen beginning at wavelength 4686, and this line was subsequently found in nebular and stellar spectra. After many attempts to reproduce these spectra in the laboratory, Fowler succeeded in 1812, by passing a powerful disruptive discharge through a mixture of hydrogen and helium. Produced only under such conditions, these must be classed as spark lines; and if Stark's views are correct and if they are really due to hydrogen, that element must have more than one detachable electron.

In applying his theory to the helium spectrum, and assuming one electron returning to a helium atom from which two electrons have been detached, Bohr obtained a formula which gives lines corresponding in position to those of the Pickering and Rydberg series, and also another series almost coincident with the Balmer hydrogen series. This remarkable conclusion was strengthened by Stark's discovery of 4686 in a helium tube which gave no lines of the ordinary hydrogen spectrum. He concluded from the canal-ray displacements that the emission centres were doubly charged. Evans also found the first members of all the series assigned to helium by Bohr, including that corresponding to the Balmer series, in a tube containing no hydrogen. The experimental evidence thus favours Bohr's theory, but we must remember the remarkable way in which the presence of one element may intensify or suppress the spectrum of another. For example, Lyman found that the ultra-violet series attributed without question to hydrogen is greatly intensified by the presence of helium. It may be added that Merton has concluded, from a study of the width of 4686, that it is due to an atom smaller than that of helium.

Some light may be thrown on this problem by observations such as those made by Wright and others on the distribution of materials in nebulæ, as indicated by the length of the nebular lines. Wright finds that usually 4686 is confined to the nucleus; helium lines extend further, and those of nebulum and hydrogen still further. These results favour the view that the elements distribute themselves according to their atomic weights, and that 4686 is due to an atom at least as heavy as that of helium. But this is not conclusive, because a high temperature line of hydrogen might be found only in the hot nucleus, if we grant the possibility of a higher degree of ionisation for hydrogen.

Fundamental questions which are of importance to physicists and astronomers alike are involved in this problem, but it is evidently an elusive one. Curiously enough, as Fowler has proved by comparison with other spectra, general series relations would permit us to assign the disputed series to hydrogen or to helium impartially, and it seems possible that both elements may give the same spectrum under appropriate conditions. Bohr has also concluded from the formula derived from the assumption of the return of an electron to a lithium atom which has lost three electrons, that lithium would emit lines close to the Balmer series. Bohr has not yet succeeded in applying his method to the case where an electron returns to a singly charged helium or lithium atom, and hence has not been able to account for the known helium lines, which are assigned by Stark to singly charged atoms. Nor has he taken account of atomic magnetic fields, which, as Humphreys, Allen, and others have shown, may exercise an appreciable influence.

One of the most fascinating fields of research is that of fluorescence and resonance spectra, in which much work has recently been done, particularly by Wood. He has found that white light will excite the complete band and line resonance spectrum of sodium or iodine, but that a single exciting line will cause the emission of a line of the same length, and also of a number of lines approximately equally spaced which may not always coincide in position with one of the absorption lines. Thus the vapour is caused to emit forced vibration, giving a spectrum not its own. As Wood has suggested, this method enables us to strike one key of the complex vibrating system of the atom, instead of the whole keyboard at once. Time does not permit a detailed account of this remarkable work, but it is evident that it may render great service in the study of the mechanism of the atom. Nor is there time even to mention any of the results obtained in the field of absorption spectra.

After reviewing the work of the past decade, we may feel encouraged by the progress that has been made both in the perfecting and application of spectroscopic methods of research and in the discovery of new phenomena. Some of these discoveries have led to fundamental revisions of our notions of atomic structure. The Rutherford atom has definitely displaced that of Thomson. In some respects this has seemed to make the problem more difficult, but it has at least defined it more precisely. Many attempts have been made to represent an atomic structure which would satisfy the necessary mathematical conditions, most of them so impossible as to be absurd or so speculative that they suggest no experimental tests of their validity. The great merit of Bohr's hypothesis is that it does lend itself to such tests, and it is for that reason that I have paid special attention to the methods of experimental attack which seem to give the most concrete results in this connection. Hesitant as we may be to accept in all its details a theory which asks us to abandon laws upon which we have pinned our faith, this theory, and the quantum theory as well, may be the flashes of genius which reveal incompletely the outlines of the truth towards which we struggle along a dimly lighted path. Fuller knowledge may resolve some of our difficulties and reconcile apparent contradictions. Ptolemy's theory of epicycles would appear wholly irrational to one acquainted with Newton's laws but ignorant of Kepler's conclusions, yet it correctly described the facts as Ptolemy saw them. Some day the Kepler and the Newton of the atom may appear, but their task will not be an easy one. If the astronomer is baffled by the problem of three bodies which he can see, how can we expect to define the exact laws determining the motions of the invisible hosts of electrons and positive charges in an atomic system? How can we hope to picture correctly the mechanism which emits radiations of almost infinite complexity, or account for the additional complications called forth by external forces? We may be almost tempted to accept the pessimistic view expressed by Planck in his Columbia lectures, that nothing in the world entitles us to believe that it will ever be possible to represent completely through physical formulæ the inner structure of the atom. And Kayser has said: "A true theory must assume a complete knowledge of electrical and optical processes, and therefore is a Utopia."

But even if we never reach the goal, who can set a limit to our approach to it? We may never set foot upon the promised land, but some day we may perceive its shadowy outlines dimly from afar.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

THE Joint Matriculation Board of the Universities of Manchester, Liverpool, Leeds, Sheffield, and Birmingham has revised its regulations for entrance to the faculties of medicine, and no longer requires that Latin should be taken as an obligatory subject. The conditions imposed by the board for entry to the faculty of medicine are now identical with the general conditions for entrance to the several faculties of the Universities.

WE learn from *Science* that the library of the late Prof. Hugo Münsterberg has been given to Harvard University by a group of his friends. The library consists of about 10,000 books, pamphlets, manuscripts, charts, and other papers. Among the 3000 books in the collection are the latest and most valuable on experimental and applied psychology, especially those bearing on aspects of the subject to which Prof. Münsterberg had devoted his time.

ACCORDING to a recent article in the *Frankfurter Zeitung* and an interview with a prominent librarian at Frankfort plans are being considered for the establishment of a general technical library at Frankfort-on-Main, to be open for public use. One of the leading city libraries has become interested in the project, and a beginning has already been made. A demand exists for a library which will be of service to all the numerous branches of the industry and trade in and about Frankfort, the most important industrial centre in South and West Germany. In this manner a broader spirit of scientific and technical investigation will be fostered. An attempt will be made to furnish technical information which will have a historical as well as a purely scientific value. Technical libraries have existed previously, but they have not been open to the general public. Such libraries have been the property of scientific societies, technical associations, and the larger industrial concerns. The service rendered by these scattered collections was comparatively small, as it was limited to members of the respective organisations owning them. These were usually hampered by lack of means and lack of facilities for organising and arranging to the best advantage. The plan that is now under way would combine these private and semi-private libraries and put them under the control of one of the established city libraries at Frankfort-on-Main. The library chosen for the purpose is the Frieherrliche Carl von Rothschildsche Offentliche Bibliothek. In addition to technical books, it is stated that the chief technical magazines of Germany and of the world are to be placed at the disposal of the public. A special feature will be the department for patent publications. Not only will the important German patent publications be provided for the library, but an attempt will be made also to furnish as broad an international list as possible.

THE South-Eastern Agricultural College has organised a research and advisory department, which is distinct from the teaching side of the college, and is governed by a separate representative committee under definite terms of reference from the governing body. This committee is composed not only of the chief research workers at the college, but also of prominent scientific men who have been co-opted to serve in advancing this side of the college activity. This seems to be an admirable arrangement. The Wye College has recently issued a very interesting memorandum outlining the work in progress and contemplated by the research department. The researches referred to are: (i) Problems connected with the general practice of fruit-growing; (ii) problems connected with the treatment of fungous diseases and insect pests by spraying; (iii) the biological study of fungous diseases and insect pests; (iv) flax experiments; (v) problems connected with the conservation of fruit and vegetables; (vi) pasture studies; (vii) investigations in diseases of sheep; and (viii) hop-breeding. The Wye College Fruit Research Station is situated in the centre of the most important fruit- and hop-growing district in the country, and it is clear from the memorandum that the main lines of research are concerned with these industries, although in almost every instance the other researches referred to have some special interest in the college area. With regard to fruit-growing, special attention is being given to the selection and classification of fruit-tree stocks, with the object of obtaining "pedigree" strains of well-known varieties, and afterwards it is proposed to investigate the relationship between "stock" and "scion." The study of fruit-growing includes the problem of combating the many fungous diseases and insect pests which become prevalent in intensively cultivated fruit areas. For the purpose of these researches the college enjoys quite a unique opportunity, being the only horticultural research station which is actually surrounded by a large fruit-growing district.

THOSE who desire to see the study of physical science receive its due proportion of school time, of prizes and scholarships and other forms of encouragement, as well as social distinction equal to that traditionally allotted to scholars brought up on purely literary fare, will rejoice to notice the newly developed liberalism of some of the classical leaders. Mr. A. C. Benson's paper at the Royal Society of Arts on December 20 last was noticed in NATURE of February 1, and now we find, in the *Fortnightly Review* for April, an article by Lord Bryce entitled "The Worth of Ancient Literature to the Modern World" (annual presidential address to the Classical Association). This article concedes almost everything fundamental which has been demanded for many years past by the advocates of educational reform. It is no doubt true, as stated by Lord Bryce, that the present popular desire for more science has been created, not as a result of any appreciation of its educational value or of pride in the achievements of the human intellect, but as a consequence of the association in the minds of the people between a knowledge of applied science and material prosperity. This is no ground for refusing to satisfy the demand, which, for other reasons, is fully justifiable. The time has come, we are told, when everyone should approach the subject, not as the advocate of a cause, but in an impartial spirit. Then Lord Bryce goes on to inquire, What is the chief aim of education? And the reply is: First, teaching the child how to observe, and from the beginning directing his attention to external Nature. Along with this he must be taught how to use language so as to be able to convey accurately what he wishes to say. An article by Mr. H. G. Wells follows that of Lord Bryce, and the subject is a review of Mr. R. W. Livingstone's recent book entitled "A Defence of Classical Education." It supplies interesting and amusing reading, which will be relished probably by everyone except the author of the book.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Microscopical Society**, March 21.—Mr. E. Heron-Allen, president, in the chair.—K. W. **Goadby**: The bacteriology of war wounds. With the aid of lantern slides and photomicrographs, prepared by C. F. Hill, the chief bacteria peculiar to the septic wounds encountered in the present war were demonstrated and described in connection with the lesions they produced.

### MANCHESTER.

**Literary and Philosophical Society**, March 6.—Prof. S. J. Hickson, president, in the chair.—Dr. H. **Wilde**: An Egyptian meteorite. Capt. Cyril Norbury, of the 7th Manchester Regiment, observed the fall of this meteorite in August, 1916, while engaged in military operations in Egypt at the extreme north of the Sinai Peninsula. The fall occurred in the early afternoon, and was attended by a loud whizzing, followed by a great thud. It was at once decided that the sounds were caused by an enemy bomb that had failed to explode, but on further search with a spade of the spot where the body had disappeared it was unearthed. Capt. Norbury noticed that a portion of the meteorite was missing, but although a careful search was made the missing portion could not be found. He also mentioned that a similar occurrence took place at the same time fourteen miles away, though the meteorite in that case was never found, but the 6th Manchesters heard a similar buzzing through the air. The weight of the meteorite is nearly 3·5 lb., and the missing parts would be about the same weight. The thin pellicle on the surface of the stone (0·02 in. deep) through which it becomes vividly incandescent during its passage through the atmosphere is indubitable evidence of its identity with those in the collection of similar meteorites in the British Museum. The Egyptian meteorite is an amorphous silicate, grey in colour, and contains microscopic particles of iron, which are diffused throughout the mass and cause a magnetised needle to adhere to any part of its surface.—Dr. A. D. **Imms**: Remarks on "castration parasitaire" in insects, with special reference to Termites. The author referred to the occurrence among diverse groups of insects of the phenomenon termed by Giard "castration parasitaire." The most striking examples are afforded by the parasitism of bees of the genus Andrena by the aberrant insect Stylops, of Bombus by the Nematode Sphærularia, of leaf-hoppers by the dryinid Aphelopus and the pipunculid Chalarus, and of the ant Pheidole by the Nematode Mermis. In Termites, Grassi and Sandias (1893) pointed out that vast numbers of parasitic Protozoa occur in the hind-intestine of the sterile castes, but not in the sexual forms. They concluded that in the former castes the degeneration of the gonads and the production of soldiers and workers are correlated with the presence of Protozoa. In the primitive Himalayan Termite Archotermopsis, Dr. Imms stated that the gonads of the so-called sterile castes are as well developed as in the sexual forms, though abundant Protozoa occur. In species of the genus Eutermes the gonads are extremely degenerate or wanting, and Protozoa are absent. The latter occur only among wood-feeding Termites, and are possibly symbiotic rather than parasitic. The balance of evidence is entirely opposed to the occurrence of "castration parasitaire" among Termitidæ.

### Paris.

**Academy of Sciences,** March 12.—M. A. d'Arsonval in the chair.—M. **Tisserand**: The mechanical culture of soils. The replacement of animals by motors on the land, already commenced before the war, has now become necessary. Attention is directed to a work by Capt. Julien, entitled "La Moticulture," in which the construction and use of such apparatus are fully discussed.—R. de Montessus de **Ballore**: Left algebraic curves.—M. **David**: The estimation of ozone. An acid solution of ferrous ammonium sulphate is used to absorb the ozone, the amount being determined by a titration with centinormal potassium permanganate.—F. **Grandjean**: The visibility, above the temperature of isotropic fusion, of boundaries of contact between the anisotropic liquids and the crystals.—H. **Hubert**: The diabases of Foula-Djalon and their contact phenomena.—M. **Jean**: The influence of extracts of genital glands on phosphorus metabolism. The injection of extract of interstitial gland and that of the yellow body from the ovary of the pig both cause a diminution in the phosphate excreted.—J. **Laborde**: The reactions of white turbidity in wines.—Em. **Bourquelot** and A. **Aubry**: The crystallisation and complementary properties of the galactobiose previously obtained by biochemical synthesis. The authors have now succeeded in preparing in crystallised form the galactobiose, the synthesis of which was described in a previous paper. As had been surmised, this sugar shows multirotation.—J. **Amar**: The classification of mutilations of the locomotive apparatus and incapacity for work.—Mlle. Marie **Goldsmith**: Some sensorial reactions of the octopus. This Cephalopod is capable of distinguishing colours, since associations can be established between the colour of an object and the sensation of feeding. There is proof of memory, but it is of short duration.—O. **Duboscq**: A new Sporozoa, *Selysina perforans*.—E. **Roubaud**: Auto-inoculation and primary development in the buccal mucus of the larva of *Gastrophilus intestinalis*.

March 19.—M. A. d'Arsonval in the chair.—M. **Hamy**: The approximate values of some definite integrals.—G. **Bigourdan**: The position and co-ordinates of some astronomical stations of Paris, utilised during the construction of the observatory.—P. **Termier**: Remarks on a recent publication of M. Maurice Lugeon. An account of a memoir entitled "Les Hautes Alpes calcaires entre la Lizerne et la Kander."—Y. **Delage**: Pharmacological equivalents and therapeutic units. The author suggests a novel and fundamental alteration in the method of writing prescriptions. The number of new synthetic drugs now used in practice is so large that it has become almost impossible to remember the doses of all of them, and, it is pointed out, there are difficulties in consulting a book in the presence of a patient. It is proposed that a list of all simple drugs and compounds in use should be drawn up and a number placed after each, indicating by weight or volume, according to the nature of the drug, the average daily dose of the average adult. This would be called the pharmacological equivalent (P.E.). For convenience, to avoid decimals, a therapeutic equivalent (T.E.) one-tenth of this would be taken as the unit. A model prescription drawn up on these lines is given. It is claimed that the method proposed would have advantages for the doctor, the pharmacist, and the general public.—G. **Charpy** and A. **Cornu-Thenard**: Tests for resilience. Irregularities in results in measurements of resilience have been attributed, on one hand, to imperfections in the methods employed, or, on the other, to actual variations in the samples of metals under examination. From the results of a large number of experiments the author has come to the conclusion that the second point of view is the correct one. The resilience of a metal is a perfectly determinate magnitude, although it presents no correlation with the usual constants obtained by traction or bending.—E. **Ariès**: The pressure of saturated vapour at low temperatures and the chemical constant.—M. Haug was elected a member of the section of mineralogy in the place of M. A. Lacroix, elected permanent secretary.—E. **Lebon**: A new table of divisors of numbers.—G. **Julia**: The reduction of binary forms of any degree.—G. **Giraud**: Hyperfuchsian functions.—A. **Buhl**: The Abelian sums of conical volumes.—L. **Hartmann**: The systematic variation of the value of the kinetic energy in the elastic shock of bodies.—A. **Leduc**: Heats of vaporisation and maximum vapour pressures. A comparison of the latent heats of vaporisation of ether and benzene deduced from the vapour pressures of Ramsay and Young, and determined experimentally by Winkelmann, Regnault, and Perot. The causes of the differences, which are considerable, are discussed.—C. **Truche**: The treatment of ulcerous lymphangitis of the horse by bacteriotherapy. The preparation of a serum is described, and the favourable results obtained by its use.—M. **Ratynski**: A treatment of infected wounds.

### Washington, D.C.

**National Academy of Sciences** (Proceedings No. 12, vol. ii.).—S. **Taber**: The origin of veins of the asbestiform minerals. Cross-fibre veins are formed through a process of lateral secretion; the fibrous structure is to be attributed largely to the mechanical limitation of crystal growth through the addition of new material in only one direction.—R. A. **Daly**: A new test of the subsidence theory of coral reefs. Existing coral reefs are new upgrowths on platforms which have been formed before, and independently of, the reefs. The submarine topography of each reef-platform structure as a whole, and the elementary principles of oceanography, declare against the assumption that the forms and spatial relations of atoll and barrier reefs are due to the sinking of the earth's crust.—A. **McAdie**: A new thermometer scale. It is suggested that the absolute zero and the melting point of ice be designated as 0 and 1000.—W. J. **Crozier**: The immunity coloration of some Nudibranchs. The coloration of *Chromodoris zebra* is a metabolic accident, at least in relation to its protection.—R. **Pearl**: Some effects of the continued administration of alcohol to the domestic fowl, with special reference to the progeny. Confirmation of previous calculations that the progeny of alcoholised parentage in poultry, while fewer in number, are made up of individuals superior in physiological vigour, and that this result is due to a selective action of the alcohol upon the germ-cells.—O. E. **Buckley**: An ionisation manometer. Use is made of the ionisation of gas by an electron discharge. The range of the apparatus is from $10^{-3}$ mm. to as low pressures as can be obtained.—H. M. **Bowman**: Physiological studies on Rhizophora. The rate of transpiration varies directly with the concentration of the medium in which the Rhizophora plants grow.—J. F. **McClendon**: The hydrogen ion concentration of sea water, and the physiological effects of the ions of sea water. It is calculated that $OH'$, $Na^{\cdot}$, and $K^{\cdot}$ increase the permeability of the plasma membrane by causing it to swell, and that $Ca^{\cdot\cdot}$, $Mg^{\cdot\cdot}$, and $H^{\cdot}$ (at least on the alkaline side of the isoelectric point) inhibit increase in permeability by inhibiting swelling.—L. B.

**Mendel** and Sarah E. **Judson**: Some interrelations between diet, growth, and the chemical composition of the body. Changes in the water, ether extract, and ash content of the body have been determined under various conditions.—T. W. **Richards** and C. **Wadsworth**: Part iii. Further study of the atomic weight of lead of radio-active origin. Atomic weight of four different examples of isotopic lead not hitherto tested was determined, with the results varying from 207·00 to 206·08.—W. H. **Dall**: Some anomalies in geographic distribution of Pacific Coast Mollusca. Observations in regard to long-continued studies by the author.—W. R. **Miles**: Some psycho-physiological processes as affected by alcohol. The percentile effects of the ingestion of alcohol upon a related group of processes, such as the patellar reflex latency, lid reflex latency, and patellar reflex amplitude, were studied.—L. R. **Cary**: The influence of the marginal sense organs on metabolic activity in *Cassiopea xamachana*, Bigelow. Muscular activity is a relatively unimportant factor in determining the metabolic activity of Cassiopea.—F. **Boas**: New evidence in regard to the instability of human types.—G. P. **Baxter** and H. W. **Starkweather**: A revision of the atomic weight of tin. The value Sn=118·703 (Cl=35·457) is found.—A. G. **Mayer**: Further studies of nerve conduction in Cassiopea.—C. **Schuchert**: The earliest fresh-water Arthropods. If the Eurypterids and Limulids arose in the fresh water we can explain why they and the terrestrial scorpions do not pass through a crustacean stage. It may well be that the Trilobites retaining the nauplius stage do not give rise to these stocks. We may look for this ancestral stock in one still more primitive which seems to have permanently invaded the rivers of the land either in Proterozoic time or in Walcott's Lipalian time.—W. H. **Longley**: Observations upon tropical fishes and inferences from their adaptive coloration. The observations here presented undermine many speculative explanations of animal coloration in terms of natural selection.

## BOOKS RECEIVED.

The Properties of Aerofoils and Aerodynamic Bodies. By A. W. Judge. Pp. x+298. (London: Whittaker and Co.) 15*s*. net.

Electric Traction. By A. T. Dover. Pp. xviii+667+illustrations and folding plates. (London: Whittaker and Co.) 18*s*. net.

Herbs Used in Medicine. (First Series.) With descriptive and explanatory notes by Mrs. J. D. Ellis. Pp. 32. (London: National Herb-growing Association.) 3*s*.

Clothing and Health. By Prof. H. Kinne and A. M. Cooley. Pp. vii+302. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 3*s*. net.

The Pruning-Manual: Being the Eighteenth Edition of the Pruning-Book. By L. H. Bailey. Pp. xiii+407. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

The Passing of the Great Race: or The Racial Basis of European History. By M. Grant. Pp. xxi+232. (London: G. Bell and Sons, Ltd.) 8*s*. 6*d*. net.

On Growth and Form. By D'Arcy W. Thompson. Pp. xv+793. (Cambridge: At the University Press.) 21*s*. net.

The Method of Enzyme Action. By Dr. J. Beatty. Pp. ix+143. (London: J. and A. Churchill.) 5*s*. net.

Descriptive Catalogue of the Documents Relating to the History of the United States in the Papeles Procedentes de Cuba, deposited in the Archivo General de Indias at Seville. By Prof. R. R. Hill. Pp. 302. (Washington: Carnegie Institution.) 4 dollars

## DIARY OF SOCIETIES.

*THURSDAY*, APRIL 12.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Wayleaves: C. Vernier.

OPTICAL SOCIETY, at 8.—Light Filters for Eye Protection: L. C. Martin.—Accuracy of Observation and Precision in Measurement: Dr. G. A. Carse.—Some Methods of Analysing Lens Systems: S. D. Chalmers.—A Simple Proof of the Expression for the Focal Power of a Thick Lens: C. Cochrane.

*FRIDAY*, APRIL 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Missing B.D. Stars: Rev. J. G. Hagen.—Observations made during the Partial Eclipse of the Sun on 1917, January 22, at the Temporary University Observatory, Rostow-on-Don, Russia: S. D. Tscherny.—The Positions of Some Pole Stars, and a New Determination of the Constants of Aberration: L. Becker.—The Motion of the Perihelion of Mercury deduced from the Classical Theory of Relativity: L. Silberstein.

*TUESDAY*, APRIL 17.

ROYAL INSTITUTION, at 3.—The Old Free Russia: Prof. C. R. Beazley.

ZOOLOGICAL SOCIETY, at 5.30.

ROYAL STATISTICAL SOCIETY, at 5.15.

*WEDNESDAY*, APRIL 18.

ROYAL MICROSCOPICAL SOCIETY, at 8—The Life-history of the Meningococci and other Bacteria: Dr. E. C. Hort and F. Martin Duncan.—Notes on *Physarum carneum*, G. Lister and Sturgis; a New British Species: H. J. Howard.

GEOLOGICAL SOCIETY, at 5.30.—The Morphology and Development of the Ammonite Septum: Prof. H. H. Swinnerton and A. E. Trueman.

ROYAL METEOROLOGICAL SOCIETY, at 5.—The Diurnal Variation of Atmospheric Pressure at Benson, Oxon., during 1915: E. G. Bilham.—Atmospheric Electrical Phenomena during Rain: Lieut. C. D. Stewart.

*THURSDAY*, APRIL 19.

ROYAL INSTITUTION, at 3.—Industrial Finance after the War; The Character of the Industrial Struggle of To-day: Prof. H. S. Foxwell.

MATHEMATICAL SOCIETY, at 5.30.

LINNEAN SOCIETY, at 5.—The Heterangiums of the British Coal Measures: Dr. D. H. Scott.—Hypophysis and Premandibular Cavities; a Suggestion: E. S. Goodrich.—Wooden Scratching Tools made by an African Parrot: Miss N. Layard.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—Annual General Meeting.—Stope Measurement at Messina: W. Whyte.—Platinum in Spain: F. Gillman.

*FRIDAY*, APRIL 20.

ROYAL INSTITUTION, at 5.30.—The Future of Wheat-growing in England: Prof. R. H. Biffen.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Presidential Address: M. Longridge.

*SATURDAY*, APRIL 21.

ROYAL INSTITUTION, at 3.—Aerial Navigation: Prof. G. H. Bryan.

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