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STARS AND NEBULÆ.

The System of the Stars. By Agnes M. Clerke. Second edition. Pp. xvi+403. (London: A. and C. Black, 1905.) Price 20*s*. net.

THERE is much excellent sense in the French proverb, "Prends le premier conseil d'une femme, et non le second," which expresses the view that the intuitive instinct of a woman is a safer guide to follow than her reasoning faculties; and although in these days it is considered ungracious to make this suggestion, evidence of its truth is not difficult to discover in most literary products of the feminine mind. It is no disparagement to Miss Clerke to say that even she shares this characteristic of her sex, so that sometimes she lets her sympathies limit her range of vision in the field of stellar research. No doubt this disposition is exercised unconsciously, but what is an attractive instinct when applied to ordinary affairs of life is derogatory when it influences the historiographic consideration of contributions to natural knowledge.

There are many students of science who follow the trend of a writer like Miss Clerke with lamb-like sequacity, and consider it almost a presumption to express any dissatisfaction with her presentment or interpretation of scientific fact. It is a sign of weakness to occupy a position of this kind; and particularly so when the author whose views are accepted is not actively engaged in the investigation of the field surveyed. Science is not a persuasion in which personal opinion has to be respected whatever the value of the material evidence in its support. We may admire Miss Clerke's literary skill and be impressed by the brilliant periods in which she frequently encloses simple matters of fact, but, at the same time, we may be permitted to recollect that she is a bibliographer rather than an observer, and therefore her works, be they never so distinguished as literature, need only be regarded as narratives by a spectator, when the weights of the results and conclusions recorded in them are being decided. There is, as Francis Bacon knew, a vast difference between opinions based upon the study of books and papers and those derived from individual observation and experience. "Studies themselves doe give forth Directions too much at Large, except they be bounded in by experience. Crafty Men Contemme Studies; Simple Men admire them; And Wise Men Use them. For they teach not their own Use; But that is a Wisdome without them and above them, won by Observation."

This statement of Miss Clerke's position is necessary by way of excuse for the temerity of a reviewer who ventures to criticise some points in a work of such a substantial character as the present one. The book has been revised so completely that scarcely a page of it remains the same as in the original edition published fifteen years ago. In this period much new work has been accomplished, and from it Miss Clerke has selected what she considers to mark essential steps in the progress of sidereal science, to incorporate with the results previously described. The task of sidereal astronomy was formerly stated to be the investigation of "the nature, origin and relationships of sixty million stars and upwards of eight thousand nebulæ," but the numbers are now "30,000,000 stars and 120,000 nebulæ." The discovery of terrestrial helium has led to the recognition of a new stellar type having helium rays prominent in their spectra, while oxygen, silicon, and titanium are among other substances the rays of which have been identified in celestial bodies in recent years. Numerous stars have been proved by the spectroscope to be close couples; and "Prof. Campbell showed in 1902 that, among the entire multitude of stars, one in six or seven is so constituted." From spectroscopic observations, it has also been possible to determine that the solar system is moving toward an apex in right ascension $277° 30'$ and declination $+20°$ at the rate of $12\frac{1}{2}$ miles a second, the probable error of the result being less than one mile a second. The demonstration of the motion of nebulæ in the line of sight has shown that there is no difference in this respect between nebulæ and stars, and has thus removed a difficulty formerly offered to the view that stars arise from a condensation of nebulous matter. Finally, the large number of variable stars found in certain globular clusters, the phenomena presented by such temporary stars as Nova Aurigæ and Nova Persei, and the structure and distribution of nebulæ in relation to the Milky Way, can only be simply and sufficiently explained by the existence in space of clouds of obscure particles alone or associated with luminous matter. The most noteworthy discoveries of astronomical science in recent years are, indeed, those which demonstrate or suggest that space may include as much dark material as bright.

Until a few years ago it was believed that nebulæ are masses of glowing gas at a high temperature; but Miss Clerke is now able to write, "experience is wholly contradictory of the notion that nebulæ are excessively hot bodies." It is scarcely too much to say that the evidence brought forward by Sir Norman Lockyer in connection with his meteoritic hypothesis of celestial evolution is chiefly responsible for the change of view that has taken place. An astronomer unfamiliar with the literature of astrophysics would not, however, derive this impression from the study of any parts of this book in which nebulæ are dealt with. Again, it is stated that a consensus of opinion regards gaseous nebulæ as being "luminous through electrical excitement"; but though this is frequently mentioned, there is no record of the suggestion made in 1888, as the result of spectroscopic examinations of meteorites, that in the Orion nebula "the hydrogen is electrically excited"; yet this observation was recorded in the original edition of Miss Clerke's book.

The low temperature of nebulæ, electrical excitation as a cause of luminosity, and the suggestion that the apparently continuous spectrum of white nebulæ, like the nebula of Andromeda, would prove to be an interrupted band of colour, are all functions of the meteoritic hypothesis. These three points have been specifically and repeatedly mentioned in connection with the hypothesis, as, for instance, in the remark that the general absence of bright lines of metallic vapours, and of the bright lines of hydrogen in white nebulæ "evidently justifies the conclusion that we are here in presence of those bodies in celestial space, the temperature and the electrical excitation of which are at a minimum, and as the continuous part of the spectrum is brought under examination further stages will be recognised. . . . There can be little doubt that when our instrumental appliances and observing conditions become more perfect, it will be found that the so-called continuous spectra will be a perfect mine of new knowledge regarding the true nature of the changes which occur as condensation increases" ("Meteoritic Hypothesis," pp. 323, 324).

This was written sixteen years ago; and the work that has since been done enables Miss Clerke to arrive at the same conclusions, though she has forgotten the observations which have changed the position formerly occupied. She can now write:—

"Gaseous nebulæ are, in fact, reasonably believed to be at a temperature not much above absolute zero. They are not, then, incandescent, but rather 'luminescent'; their light is independent of thermal conditions."

Also we find in several places the view accepted that even the spectra of white nebulæ are not truly continuous, but show

"slight inequalities in the flow of light, indicating effects of absorption, of emission, or of both combined."

In the present state of knowledge of nebular spectroscopy, no opinion of substantial value can be expressed as to the relationship existing between nebulæ exhibiting the characteristic line at λ 5007 alone or with other lines, and nebulæ with apparently continuous spectra, but the view that the difference is due to different degrees of condensation of congeries of meteoritic matter—cosmic dust—the Andromeda type of nebula being in a more condensed condition than an irregular nebula like that of Orion, is at least as reasonable as any other. Even if this suggestion is considered to be of negligible value, there remains the fact that the present tendency is to regard the spectra of all nebulæ as being really discontinuous, as was anticipated in the meteoritic hypothesis. Moreover, Miss Clerke admits that, apart from the question of the apparent differences between the two spectroscopic types of nebulæ,

"relationship between the various orders of nebulæ is manifest. The tendency of all to assume spiral forms demonstrates, in itself, their close affinity; so that to admit some to membership of the sidereal system while excluding others would be a palpable absurdity. And since those of a gaseous constitution must be so admitted, the rest follow inevitably."

It is not clear from this, or from other remarks in the book, how we are to regard the white nebulæ, if only as a working hypothesis. Most spiral nebulæ do not give the characteristic spectrum of hydrogen and helium, yet it is agreed that all spiral forms are closely related. If it is assumed that the spiral nebulæ with bright line spectra are entirely gaseous in constitution, it is difficult to explain the existence of apparent "stars," presumably at a higher temperature than that of the general mass of gas, threaded upon the spirals. If, however, the view is accepted that the luminous radiations of so-called "gaseous" nebulæ are really only the visible manifestations of electric or dynamic disturbances of a mass of cosmic dust—and few would now deny the existence of dark matter in nebulæ—the explanation of spiral nebulæ is easy, and the difficulty as to the relationship between these nebulæ and others disappears. The existence of streams, sheets, and shells of palpable matter intersecting at various points is sufficient to account for the bright portions of spiral nebulæ with the apparent stars arranged along the spirals; if nebulæ have this meteoritic constitution spiral forms ought to predominate, as they actually do. Spiral nebulæ like those of Andromeda and Canes Venatici are certainly not purely gaseous in constitution, though a few years ago it was more necessary to insist upon their non-gaseous nature than it is now; but while we await crucial observations to decide how nebulæ of different spectroscopic types are related, Miss Clerke might have shown that an explanation has been given, though she may disapprove of it.

A knowledge of the constitution of nebulæ is of fundamental importance, for upon it must be based any satisfactory scheme of evolution of celestial species. All astronomers accept the idea of evolution from nebulæ, but as to the order of development, and the means by which it is brought about, no hypothesis has met with general adoption, even as a working principle. A common ground of agreement, however, is that nebulæ showing the characteristic trio of lines—λλ 4860, 4950, and 5007—in their spectra are at a relatively low temperature. Given the cosmical amœba in the form of a nebula, what will become of it? The question cannot be answered directly, because sidereal ontogeny transcends human experience; but though the development of the individual nebula cannot be followed, a sidereal phylogeny can be based upon the spectroscopic characters of celestial species. Miss Clerke does not deal with nebular and stellar spectra from the point of view of development; for she takes Secchi's four types of spectra as her groups for discussion, and only makes incidental reference to the stages occupied by particular stars in an evolutionary scheme. The helium-stars, typified by certain stars in the constellation Orion, are regarded as the first results of condensation from nebulæ; Sirian stars represent the next stage, and then the solar condition is reached.

"In a general sense it may indeed be said that the spectra of the sun and of solar stars imply a state of things in their reversing layers analogous to that prevailing in the arc-light, while in helium and Sirian stars the conditions of the spark are more nearly reproduced."

From stars of the solar type, Miss Clerke suggests that the development is toward the condition of Betelgeux, which exhibits the Fraunhofer spectrum in association with titanium flutings or bands, then to α Herculis, in which "the bands have acquired strength through the efflux of time, it is supposed, and the progress of cooling." Further than this she does not go, Secchi's fourth type of stars, showing absorption flutings of carbon in their spectra, being regarded as a class apart, and not united to the sun and its congeners in an evolutionary series.

In this classification of stellar spectra, temperature is not considered as an essential factor or a concomitant of the changes described; the question of the temperatures of the stars forms the subject of a separate chapter, new to the present edition. Heat is not entirely discarded, but "luminescence," "radiology," and "electrical excitement" now appeal to Miss Clerke's affections, and she flirts with them whenever she has the opportunity, though little is known of their resources. By this course she is able to believe, with Sir William and Lady Huggins, that solar stars are hotter than Sirian stars, while she acknowledges, as has been shown, that arc-lines are characteristic of the former type of spectra and spark-lines of the latter. Whether the temperature of the electric spark is actually higher than that of the arc has yet to be decided, but solar stars can only be placed at a higher temperature-level than white stars by neglecting much circumstantial evidence in support of the superiority of the spark. As a matter of fact, laboratory observations, so far as they are available, show that the same spectra can be produced by thermal or electrical action. Under conditions from which electrical influences were probably excluded, and the spectra obtained were due solely to high temperature, nitrogen at temperatures above 3000° C. has been found to give an emission spectrum in which the principal lines characteristic of the element were visible (Nasini and Anderlini, *Atti dei Lincei*, July, 1904). The agency by which gases and vapours are rendered incandescent seems, indeed, to be inconsequential, and high temperature is probably competent to produce the same spectroscopic results as those observed when incandescence is caused by the oscillatory discharge.

Electric and thermal effects cannot, however, be distinguished from one another in stellar spectra; therefore any attempt at a temperature classification must provide for possible electric influences. It was recognised by Sir Norman Lockyer more than thirty years ago (Roy. Soc. Proc., vol. xxii., p. 372, section ii., June, 1874) that the action of electricity must be included in the term "temperature"; and while the chemical changes effected by thermal and electric forms of energy cannot be discriminated in celestial spectra, the aim should be to construct a chemical classification without waiting for a complete understanding of the active causes of atomic vibrations or molecular combinations revealed by the spectroscope.

From whatever point of view stellar spectra are studied, little support can be found for the conclusion that the solar stars are at a higher temperature-level than the white stars. From a comparison of the spectra of Capella and Vega—typical solar and white stars respectively—Sir William and Lady Huggins concluded that "The solar orb seemed intrinsically the *bluer*, and was inferred to be the hotter of the two"; but neither the observation nor the inference can be regarded as established. Adopting the relative length of the ultra-violet spectrum as a criterion of stellar temperature, observations show that solar stars are really weaker in ultra-violet rays than white stars. In a paper on "Radiation through a Foggy Atmosphere" (*Astrophysical Journal*, vol. xxi., No. 1, January, 1905) Prof. Schuster accepts "the comparative weakness of the ultra-violet radiation in solar stars" as a fundamental fact which he attributes to molecular scattering in the photospheric regions of these bodies; but whatever the explanation, it is clear that spectroscopists have not adopted Sir William and Lady Huggins's view as to the ultra-violet spectrum of solar stars, but hold an opinion directly opposed to it. The extension of spectra into the ultra-violet may be regarded as the result of increased temperature, but by this standard white stars are placed above solar stars, and not below them.

All standards of comparison should, however, lead to the same spectroscopic succession if they are true tests of evolutionary development of celestial species. The sequence derived from comparisons of the lengths of ultra-violet spectra is the same as that revealed by the presence of gaseous and metallic lines of helium and hydrogen, and the enhanced and arc lines of the metals. In stars which have relatively the longest ultra-violet spectra there are few absorption lines; iron is represented practically by the enhanced lines alone, and the lines characteristic of the arc spectrum are almost or entirely absent. Only by considering the length of the ultra-violet spectrum together with the presence or absence of iron lines and lines that are intensified in passing from the condition of the arc to that of the spark can a useful classification of stellar spectra be established. When this principle is adopted a chemical classification of spectra becomes possible, and a reasonable scale of stellar thermotics is arrived at. From a hot star like Bellatrix a descending series can be arranged through β Persei, γ Lyræ, Sirius, Castor, and Procyon to Arcturus—a relatively cool star—by considering the changes in the spectrum of any constituent in passing from one grade to another. A continuous ascending series of spectra reaching up to Bellatrix can also be arranged from the spectrum of nebulæ of the Orion type through planetary nebulæ and the Wolf Rayet stars showing the line λ 4688 in their spectra to Orion stars in which this line is dark. This arrangement of spectra corresponds also with the sequence which would be expected as the result of various degrees of chemical dissociation at different temperatures. Stars having the smallest number of chemical elements represented in their spectra are probably the hottest, while an increased number of lines in other spectra is probably due to the existence of an increased number of chemical elements as the result of lower temperatures, the inferior position on the temperature scale being indicated also by the reduction of the relative length of the spectrum, increase of the relative intensity of red radiation and general absence of enhanced lines. Little is said about this chemical classification by Miss Clerke, and nothing in its favour, yet it represents the conclusions of a lifetime devoted to the study of spectra in the laboratory and observatory, and abundant material relating to it appears in the Proceedings of the Royal Society. Anyone unfamiliar with this material who reads what Miss Clerke has to say upon the temperatures of the stars and the interpretation of stellar spectra would have an inadequate idea of the results of systematic studies of these subjects, or of the existence of substantial ground of appeal against her verdict.

An instance of an incomplete statement that tends to mislead the reader is afforded by the note on Sir William and Lady Huggins's experiments on the behaviour of the H and K lines of the spectrum of calcium (Roy. Soc., June 17, 1897). By reducing the density of calcium vapour the lines H and K were obtained alone, and it was concluded that the various appearances of calcium lines in celestial bodies were due to the different states of density of the gases from which the lines were emitted or absorbed, and not to degrees of dissociation. The H and K lines in the solar spectrum are considered to prove the existence of "the metal calcium in a highly rarefied state"; and upon this evidence, referring to the condition of this element, Miss Clerke remarks:—"The hypothesis of its dissociation in the sun thus remains unverified." As a matter of logic, the experiments only prove that the H and K lines of calcium are spectroscopically persistent, and were able to survive (as might have been expected) conditions which effaced weaker lines in the spectrum of the element. Because brachiopods belonging to the genus Lingula are found in the sea at the present day as they were in Palæozoic ages, while many other forms that were contemporary have disappeared, we do not conclude that organic evolution is impossible, but only that the organism represents a type which persists in spite of changes of conditions. In the same way the continued existence of the H and K lines affords no evidence whatever against the view that there are different molecular groupings of calcium at different temperatures. By reducing the density of the calcium vapour, Sir William and Lady Huggins reduced the quantity acted upon; so the dissociated condition represented by the appearance of H and K alone was reached sooner. Similar experiments were made by Sir Norman Lockyer in 1879, and the conclusion arrived at was that a reduction in the quantity of a substance generally simplifies the spectrum. "In all probability the effects hitherto ascribed to quantity have been due to the presence of the molecular groupings of greater complexity. The more there is to dissociate, the more time is required to run through the series, and the better the first stages are seen" (Roy. Soc. Proc., vol. xxx., p. 26).

It will be seen, therefore, that the principal point of Sir William and Lady Huggins' experiment on calcium vapour at different densities was the subject of laboratory experiments more than twenty years earlier, and that their conclusion, though it is mentioned by Miss Clerke without reservation or reference to previous investigations, is not a safe one to apply to the consideration of the condition of calcium in the sun or stars as indicated by spectroscopic appearance. Moreover, if the changes of the calcium spectrum are interpreted as effects of tenuity, the similar spectral variations of magnesium and iron ought to admit of a like explanation, whereas there is good evidence that they are due to constitutional changes brought about by thermal or electric action.

Many other debatable matters are dealt with by Miss Clerke in a manner which suggests that the last word has been said upon them when she is really only presenting one side of a case. It may be assumed that, like a good advocate, she is as familiar with the defendant's case as she is with the plaintiff's, but the real strength of the evidence opposed to the views she adopts could only be shown by the disciple of another school of spectroscopy; and a small volume would be required to plead this cause. No writer on astronomy has a more facile pen than has Miss Clerke, and we can forgive the occasional florid style when we remember the vast amount of reading and careful analysis involved in the preparation of a volume of this kind. The work is so good that every student of astronomical physics must be familiar with it, and every astronomical library must include it. Because of its essential qualities it is to be regretted that a broad view has not been taken of all contributions to the subject made by competent investigators; for by neglecting such aspects as have been referred to in the foregoing paragraphs an incomplete story is presented of the meaning and mysteries of sidereal development revealed by spectroscopic research.

R. A. Gregory.

BRITISH ASCIDIANS.

The British Tunicata: an Unfinished Monograph. By the late Joshua Alder and the late Albany Hancock. Edited by John Hopkinson, with a History of the Work by the Rev. A. M. Norman, F.R.S., &c. Vol. i. Pp. xvi+146+xx plates. (London: Printed for the Ray Society, 1905.) Price 12*s*. 6*d*. net.

THERE are probably few precedents for the publication of an unfinished biological monograph thirty years after the authors penned their last remarks, especially of a monograph dealing with a group which has been the object of much detailed investigation by other hands in the interval. The chequered history of the present work is briefly, but sympathetically, told by Canon Norman, from whose preface the following paragraph may be extracted:—

"Though so many years have elapsed, the value of this Monograph is great, since (1st) it contains full descriptions with illustrations of the Tunicata of our fauna as known up to the time of the death of the authors; (2nd) because many of the new species had been only briefly diagnosed, and the fuller descriptions and figures of these which are now given will enable them to be better known and understood; and (3rd) it is especially desirable that the full account of Hancock's investigations should be published together with a portion of his beautiful drawings."

For these reasons the student of the Tunicata cannot be otherwise than grateful to the Ray Society for the publication of this work, and especially for the liberality with which it has been illustrated. The coloured figures representing many of the authors' species must rank among the best figures of ascidians extant, and the numerous collotype reproductions of Hancock's drawings of the branchial sac, &c., will greatly facilitate the task of identification.

The first volume, which we hope may soon be followed by the remainder of the work, contains (1) the authors' introduction (a historical summary of British records of Tunicata up to the year 1870), (2) a reprint of Hancock's paper "On the Anatomy and Physiology of the Tunicata" (published by the Linnean Society in 1867), and (3) an account of thirty British species referred by the authors to the genus Ascidia. Two of these so-called species are now described for the first time, viz. *Ascidia amoena* and *Ascidia Morei.*

It is no discredit to the memory of the distinguished authors of this monograph, whose general accuracy of observation has long been established, if we express a conviction that no modern expert in this group of marine animals will be prepared to recognise the claims of half Alder and Hancock's "species" to specific rank. It is not improbable that the thirty forms described in the monograph will be ultimately referred to some ten or twelve "good species" at most.

Excluding *Ascidia canina,* the relations of which to *Ciona intestinalis,* L., appear, strangely enough, to have been overlooked by Hancock, the remaining twenty-nine species of Ascidia, as described by the authors, would in these days be referred to the three genera Phallusia (with the single species *mamillata*), Ascidia and Ascidiella of Roule. Adopting for the moment Alder and Hancock's specific names, and confining our attention to the forms dealt with in their monograph, we may say that each of the genera Ascidia and Ascidiella includes three main types. To Ascidia (*s. str.*) belong (1) *mentula,* with which *robusta, rubicunda,* and *rubrotincta* are probably synonymous; (2) *mollis,* with *crassa, plana, Alderi,* and possibly *rudis,* as allies; and (3) *plebeia* (= *conchilega* of Müller), with which *producta, inornata,* and *depressa* are closely related or synonymous. To Ascidiella belong (1) *obliqua* (= *prunum* of Müller), to which the new species *amoena* appears to be related; (2) *venosa,* and (3) a large series of very variable forms referable in the main to the types *sordida* (= *virginea* of Müller), *scabra,* and *pustulosa* (= *aspersa* of Müller), of one or other of which the authors' "species" *elongata, aculeata, Morei, Normani, affinis, elliptica, pellucida, orbicularis,* and *vitrea* appear to be merely varieties or local forms.[1]

There is probably no group of animals in which external conditions exert a greater influence upon the size, shape, and structure of the body than in the case of the ascidians, owing to their permanent fixation under the most diverse natural conditions, their mode of feeding, and the plastic character of the test which serves them for a skeleton. Differences in the supply of food alone—and no factor is liable to greater extremes than the amount of phytoplankton in littoral waters—must influence the development of an ascidian's body in so many different ways that great variability must be the rule rather than the exception. In these circumstances it is doubtful if the natural history of this group can be adequately treated in any monograph until much additional work has been done, not only in the systematic observation of the nature and extent of local variations, but also in direct experiments concerning the effect of different conditions upon the growth of the progeny of selected parents. Until such work has been done, any attempt to define specific limits within (*e.g.*) the *virginea-scabra-aspersa* group must remain a mere expression of personal opinion.

In the meantime the publication of the present work is likely to lead to the clearing up of many uncertainties, provided it is regarded mainly as a repository of facts, and not as an authoritative guide to the classification or nomenclature of the group.

This aspect of the work has been fortunately retained under the editorship of Mr. Hopkinson, who has restricted his notes to the addition of such bibliographic and distributional records, published prior to 1871, as were necessary for the completion of the authors' MSS. up to the date of Hancock's latest work. The editorial footnote "on the intimate relationship existing between the Tunicata and the Polyzoa," on the first page of the authors' introduction, conveys just the right touch of archaic suggestiveness.

We notice a couple of misprints: Weigmann for Wiegmann (pp. 7 and 12), and Mongula for Molgula (p. 46); and may point out that Figs. 8 and 9 on plate xi. represent not "probably a variety of *Corella parallelogramma,*" but Hancock's own species, *Corella larvaeformis,* which we presume will be described in the second volume of the monograph.

W. GARSTANG.

[1] For a fuller discussion of the relations of particular species special reference should be made to Prof. Herdman's paper in *Jour. Linn. Soc.*, xxiv., 1893, and Hartmeyer's "Holosome Ascidien" in "Meeresfauna von Bergen," 1901.

THE METALLURGY OF IRON AND STEEL.

Elementary Practical Metallurgy, Iron and Steel. By Percy Longmuir. Pp. xiii+270+13 plates. (London: Longmans, Green and Co.) Price 5*s.* net.

WORKS on practical metallurgy have generally consisted of descriptions of series of experiments suitable for performance in an ordinary laboratory possessing the usual equipment with small assay furnaces; but this book is an elementary work on the metallurgy of iron and steel, written with the view not only of serving the needs of the ordinary beginner among students, but of attracting the severely practical man to the study of metallurgical literature, and thus helping him ultimately to the position of being able to throw the light of new discoveries on his daily work, and to make application of suitable results—evidently a practical apostle of the methods of the British Science Guild. The writer thoroughly agrees with the author that "Such a work should not be overloaded with detail, but the facts presented should be accurate and the matter reliable," for nothing more certainly repels the very specially practical man than a mass of finical hedgings, which are only fit for discussion among philosophers, but do not affect the main present issues. While this is so, looseness of expression is the last thing to permit oneself, as no type of man more appreciates accurate statements if they are simply expressed. While the author has in the main succeeded in his ideal, there are some points which the writer would change. Thus, p. 7, "Elasticity . . . is the length to which . . . ." Similarly, tenacity, breaking load, ductility, and ductility as applied to wire-drawing are not satisfactory. Interesting and simply written chapters on refractories, iron ores, and the blast furnace follow. The author's wide practical experience in foundries lends a special interest to his chapters (vi. to ix.) on pig- and cast-irons, for in the works he was daily brought into contact with the adjustment of those properties of cast-iron to the fulfilment of the orders on hand, and this may account for his almost bitter treatment of the enemy, sulphur, which is perhaps not quite so black as he has painted it.

These chapters should also show why there is such a fascination in the study of this complicated material. Next comes a good chapter on malleable cast-iron, but a statement on p. 128 is a little confusing. British malleables are said to contain something like 0·3 per cent. S, which agrees with the writer's experience. Then it is stated that grey hæmatite refined is used, but this would really contain less than 0·1 per cent. S. The fact seems to be that a material called refined hæmatite, but really white hæmatite re-cast into small pigs, is used, and the old refined grey pig is not obtainable on the open market.

In comparing the Siemens and Bessemer processes, the important point of the much smaller percentage of loss in the open-hearth seems to have been omitted. The crucible, Bessemer, and open-hearth processes are described in considerable detail, and p. 227, on the production of sound steel, is excellent, while it was only to be expected from the author's researches that the influence of casting temperature would be adequately dealt with. Chapters xviii. and xix., on the metallography of the heat treatment of steel and of hardened steels, are profusely illustrated, and deal with the subject from the carbonist's point of view, with the intimation that there are other theories, a wise decision, as whichever of the many theories may prove to be the correct one, that given is the easiest to understand, and the reader may search out the others if so minded. The author, in using for illustration microsections of articles he has used, such as hack-saw, table-blade, razor, and file, sets the seal on his desire to attract the practical man, and if on examining similar tools he should find different structure it ought to stimulate inquiry. The final chapter on special steels, while good in itself, will impress on the reader that there is much—very much—more beyond. The work, which is printed on matte surface paper, most agreeable to the eye, with thirty-one of its sixty-four illustrations printed on smooth paper to bring out the required detail, can be recommended to the beginner as a "book which will primarily awaken interest."

A. McWilliam.

OUR BOOK SHELF.

Glue, Gelatine, and their Allied Products. By Thomas Lambert. Pp. xii+153. (London: Chas. Griffin and Co., Ltd., 1905.) Price 5*s*. net.

This is a handbook intended for the use of glue manufacturers, agriculturists, and students of technology. It describes the preparation and properties of glue and gelatin, and also of certain side-products, such as size, cements, and fertilisers. The description is written chiefly from the practical standpoint, though some notes on the chemistry of the products are included. Diagrams of plant and machinery illustrate the working of the various processes mentioned in the text.

While the book contains much trustworthy information, there is some confusion in its arrangement. Thus the first chapter purports to be "historical," but it deals principally with matters quite other than historical; as, for example, "chondrin and its properties," "railway accommodation," "water supply," and so on. Moreover, it would, we think, have been better if the author had written either specifically for manufacturers or specifically for the manufacturing chemist, instead of addressing himself sometimes to the one and sometimes to the other. The manufacturer, for instance, hardly wants a detailed description of Kjeldahl's method of determining nitrogen; on the other hand, the chemist might well be spared the statement that "all crops contain certain mineral matters in their ashes."

The book would form a good nucleus for better things. With some re-arrangement of its subject-matter, and a less superficial treatment of the chemistry involved, it might develop into an excellent manual of the technology of glue and gelatin.

C. S.

Webbia-Raccolta di Scritti Botanici pubricati in occasione del 50° anniversario della Morti di Fillipo Barker Webb. Edited by Prof. U. Martelli. Pp. xi+393. (Florence: S. Pellas, 1905.)

Philip Barker Webb, in whose honour this volume has been compiled, lived in the first half of last century; during his career at Oxford he developed a taste for the classics and natural history which a substantial patrimony allowed him to cultivate. In the course of his travels he visited Spain, Portugal, the Canary Islands, and other countries, combining botany and geology with pleasure. He resided generally in Paris during the intervals between his journeys, and there he directed and carried out the work in connection with the "Phytographia Canariensis"; also he accumulated a large herbarium, including several French collections. At his death his botanical treasures were lost to France, as he bequeathed all his plants and books, together with a sum of money for their maintenance, to the Grand Duke of Tuscany.

This volume contains a number of original papers that have been contributed by Italian botanists as a token of gratitude for the stimulus which these collections have given to Italian botany. Most of the papers are concerned with systematic botany. Prof. O. Beccari, writing about palms, contributes an account of the Indian genus Trachycarpus, allied to Chamærops; a list of species from New Guinea, including a new genus, Barkerwebbia, under the Arecineæ, and a revision of the order for the Philippines. Prof. U. Martelli describes a number of new species of Pandanus. A review of European umbellifers, in which the writer includes the Araliaceæ, forms the subject of a lengthy paper by Dr. B. Castellani. Prof. E. Bartoni publishes a short MS. by Parlatore on Linnæus's herbarium which is especially appropriate, as Webb and Parlatore were friends, and held each other in mutual esteem.

A Course in Mathematical Analysis. By Édouard Goursat. Translated by E. R. Hedrick. Vol. i. Pp. viii+548. (London and Boston: Ginn and Co., n.d.) Price 16*s*.

THIS readable and trustworthy translation will be welcome to those who cannot enjoy the original, the merits of which are by this time well known. The typography is unusually good, and is very creditable to all concerned, such symbols as the square of a_1, or even of a', being printed in a satisfactory way, which English printers might imitate with advantage. There are a few terms here and there which are ungrateful to an English ear; "involutionary" or "involutional" would be more agreeable to analogy than "involutory," and "nappe" is retained instead of being rendered by "sheet." But these are trifles, and those of us who have no French can now study a treatise which is eminently lucid and attractive, as well as being up to date and sufficiently rigorous for the purpose it is designed to fulfil.

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.*]

Agriculture and the Empire.

THE article by Sir W. T. Thiselton-Dyer in your issue of March 22 is a fair statement of the position the Home Country should take in the development of agriculture in the Empire at large, and of the necessary training the future experts and researchers in Indian agriculture should receive; and this view requires pressing upon those responsible for the development of agriculture in our colonies, so that the policy of employing as agricultural experts men with a mere smattering of scientific method, combined with a more or less thorough knowledge of British agriculture, may not be followed. Investigation and careful research are wanted, and the only men who can perform this are those whose sense of proportion and scientific methods of attack have been developed by a systematic training in the sciences having a bearing on agriculture. Agriculture is at once a science, an art, and a business, and the successful agriculturist at home must be a man equipped with an adequate knowledge of all these subjects, combined with a special ability for one or more of them.

The agricultural colleges of Great Britain afford a training in the science and art of agriculture, but on the business side of the subject not much can be attempted, as personal experience and responsibility of the individual for his business transactions are necessary conditions. Many agricultural colleges and agricultural departments of our universities possess the necessary scientific equipment and a staff of adequate attainments to give to the future Indian or colonial expert a thorough systematic training in such sciences as chemistry, botany, and zoology, in an agricultural atmosphere. The latter condition must be of immense importance in impressing on the student the relations of the pure science to practice; and although the practical application he will experience abroad will differ essentially from that observed at home, he will at all events be prepared to use his science to solve problems of economical value, and, if his training has been broad and thorough, to become a most useful factor in developing the agriculture of the country. It is certain that a man trained at an agricultural college or at an institution equipped with the necessary facilities for the study of animal or plant life will be better able to enter upon his duties as investigator of agricultural science in India than a man whose training has been received at the ordinary technical college. From the staff and students of this college during the past few years experts have gone: to South Africa, four, including the director of the Transvaal Agricultural Department; to India, four, including two to Pusa; to British Guiana, the West Indies, and Egypt, two, as well as to other countries, so that it can claim some connection with agriculture in our colonies.

Sir W. Thiselton-Dyer says that notice should be given five years in advance of the requirements for trained men; with this opinion I agree, though I doubt its practicability. What we require is more men of recognised ability to train for such position. Hitherto some branch of technical work other than agriculture has been the object, to a great extent, of the trained student, but now that there is a future for highly trained men who will bring their scientific knowledge and spirit of investigation to bear upon the problems of agriculture at home and abroad, we hope that men of the right stamp will come to be trained partly perhaps in this country, and afterwards under the conditions in which their future work will lie, but in any case to go through a complete course of systematic study in the science to which they intend to devote themselves when they have gained their technical experience. It is a fact, and one to be deplored, that the agricultural students are not always drawn from the best of our rising generation, since farming is looked upon as the profession to be engaged in by those "who are too clever for the Army and not stupid enough for the Church"; but now that we can offer a field for a well trained man to make a name and a living in the domain of agricultural research, we should secure a greater proportion of suitable men. In this country, for the researcher, apart from the teacher, there is little chance for a trained man to earn a livelihood, but abroad, where the resources of the soil have yet to be developed, there is a good prospect of employment for men who are thoroughly equipped with the requisite scientific knowledge and possess the spirit of investigation.

Another point to which Sir W. Thiselton-Dyer has directed attention is the proper teaching of science in our rural elementary schools, and, I would add, our rural secondary schools. How often do we see, especially in the latter class of school, the teacher (who is often selected for his chemical knowledge) teaching by book alone, and without reference to the conditions amid which his scholars live. Chemistry is one of the least suitable of the natural sciences to teach children whose lives will be, or ought to be, spent in the country. Botany or zoology taught by a teacher who has learnt these subjects, and has been trained in their application to outdoor life as it exists in an English farm or country village, would be far preferable, and I venture to think that Kew, the agricultural departments of our universities, and our agricultural colleges could supply such teachers, and so could influence to a considerable extent the value of the teaching in country districts.

The Board of Education has, I understand, the latter matter in hand, and I trust that under the advice of their excellent rural inspector a scheme will be formulated which will in some way check the tendency of modern education to prepare solely for town life. M. J. R. DUNSTAN.

South-Eastern Agricultural College (University of London), Wye, Kent, March 26.

Sea-sickness and Equilibration of the Eyes.

MANY people have no doubt noticed, when travelling by sea, that the motion of the ship could be *seen* very distinctly, even when there were no hanging lamps, draperies, or fixed points, such as the horizon or clouds, within range of sight.

Some may think that seeing the motion in this way is due to the imagination receiving its suggestions from the motion of the internal organs, and especially the stomach, for I am here supposing the body to be held perfectly rigid.

From observations which I have recently made it seems evident to me that the cause for seeing the motion is entirely different.

In the first place, you can always see the motion a fraction of a second before you begin to feel it. In the second place, you cannot see a perfectly horizontal motion or a gentle vertical (heaving) motion. In the third place, watching a fixed point close to you, such as a pattern on a carpet, when the ship is pitching and rolling, is far more tiring to the eyesight than when the ship is motionless or running perfectly steadily. All this points to the appearance being due to a true relative motion of the eyes to the ship.

The eyes are suspended in their muscular settings, much in the same way as are ships' compasses in their binnacles. The eyes are, furthermore, perfectly balanced, so as to make their muscular displacements as little tiring as possible. In their normal position, the pull of gravity is exerted vertically through their centres, and the muscular mechanism is compensated for gravity.

Any angular change of position will displace the eyes just as it displaces the stomach, excepting that the eyes, being a great deal more sensitively suspended, will register the displacements more quickly. It is not, however, the motion of the eyes which strains the eyesight, but the act of resisting this motion.

If, with your eyes shut, you attempt to fix the mental representation of a point, which a moment previously you were watching with eyes wide open, you will find that, after one or two motions of the ship, the bodily feeling will precede any visual sensation which your imagination can conjure up. The imaginary point is no longer fixed, but follows the eyes as they let themselves go to the motions of the ship. No strain of the eyesight is caused by a muscular resistance, and the displacements, while felt, can no longer be seen.

Alfred Sang.

Pittsburg, U.S.A., February 26.

Production of an Electrically Conductive Glass.

Experiments have from time to time been made, both in England and abroad, to ascertain what ingredients are best for the purpose of producing glasses of very high electrical resistance.

The utility of a vitreous substance which would conduct electricity comparatively well does not appear, however, to have so far claimed any consideration.

I beg therefore to direct attention to a glass which has recently been made in my laboratory. Its chief feature is that it readily conducts electricity.

For the windows or cases of electroscopes and all high-tension apparatus requiring a transparent cover capable of screening off external electrical fields, this material offers many advantages. A conducting varnish is no longer required for glass which conducts electricity itself. In addition to these practical considerations, there arises the interesting question as to the process by which electricity passes through this substance—whether it is electrolytic. Its resistance varies very markedly with temperature changes. I hope later to give more precise details. The basis of the glass is sodium silicate.

Charles E. S. Phillips.

Shooters Hill, Kent, March 12.

Interpretation of Meteorological Records.

In discussing the records of the meteorological instruments at Canterbury (Nature, March 15), Dr. Aitken suggests that the heavy rain which fell dragged down the higher air, and so caused the fall of 12° indicated on the thermograph curve, and he very clearly and convincingly shows the consequent effect on the barometric pressure and wind velocity. If, however, the air had been in a state of stable equilibrium previous to the thunderstorm, the effect of such a mechanical dragging down of the higher air would have been to heat by compression that air so much that the temperature would have been raised rather than lowered at the ground-level. But if, previous to the storm, the upper air had from any cause become very much colder than the lower air, the atmosphere would be in a state of unstable equilibrium, that is to say, the rate of change of temperature with height would be greater than the adiabatic rate of change due to heating by compression of descending air. In such a case the changes recorded by the various curves may have been initiated by this heavy cold air suddenly descending and displacing the lower air, which by its sudden uprising would be cooled, the moisture in it condensed, and a heavy fall of rain caused.

The lightning which accompanied this storm introduces an element of uncertainty into any attempted explanation, for we do not know yet the manner in which electric charges are generated in the atmosphere. But it seems probable that a great cooling of the higher air is an accompaniment of a state of electric tension, for it is difficult to see otherwise why a thunderstorm should be followed by a lowering of the temperature near the ground-level.

R. T. Omond.

Edinburgh.

Oscillation of Flame Cones.

I should be glad if any of your readers could give an explanation of the cause of the following flame phenomenon, produced while experimenting with a modification of Prof. Smithells's apparatus for the separation of the cones of a Bunsen flame.

A mixture of gas and air is burned at the top of a vertical tube (made preferably of combustion tubing) about 4 feet long and ⅞ inch to 1 inch in diameter, having a delicate screw adjustment for regulating the proportions of gas and air.

The air supply is carefully and slowly increased, until an almost explosive mixture is reached, and the inner cone is very short and sharp and of a light green colour. On admitting a very slight increase of air after this point, the inner cone (sometimes the two cones) descends the tube to a distance of about 2 feet, and then pauses and goes up again, re-joining the outer cone. The flame then "sharpens" again and repeats the process, and will continue to do so for several hours without further adjustment of the gas or air being made.

There is every appearance of an explosion wave being propagated, as shown by the increasing velocity of the descending flame and by the occasional emission of a note as it reaches the end of the travel.

The length of travel can be regulated by the amount of air admitted, varying from 1 or 2 inches to about 2 feet in the same tube. If it be allowed to exceed a certain limit the inner cone is extinguished at its lowest point, but immediately re-lights at the top of the tube, and then returns as before. The periodicity can be varied from about once in five seconds to once per second.

The gas pressure does not need any special regulation, the ordinary variations from a town supply not affecting the results.

The following are the points requiring explanation :—

(1) As the proportions of gas and air are constant, what is the cause of the periodic "sharpening" of the cones after meeting at the top of the tube?

(2) What prevents the explosion wave being completed, and the consequent firing back of the mixture?

(3) What causes the inner cone to return and travel up the tube, re-joining the outer one at the top?

(4) The alteration in the character of the flame (in view of the fact that the proportions and pressure of gas and air are constant) points to some form of wave motion bringing the molecules into closer contact. If this be so, what are the conditions which set up this wave motion and what determines its periodicity?

Harold E. Temple.

Olton, Warwickshire.

The phenomenon described in the foregoing letter is in part dealt with in a paper by Dr. Ingle and myself in the Transactions of the Chemical Society for 1892 (vol. lxi., p. 204). The continued oscillation of the inner cone is, I think, explained by the fact that the mixture of gas and air in the tube is not uniform. We have, indeed, found it necessary to use elaborate mixing appliances to make it uniform. When a portion of the mixture rich in air reaches the top of the tube the inner cone is propagated through it and descends until it reaches a stratum richer in gas, when it re-ascends. The fluctuation in the composition of the gaseous mixture escaping from a Bunsen burner can be seen by the throbbing of the inner cone, when the air supply is considerable. I may add that in the construction of burners for the incandescent mantle great importance is attached to the perfect mixing of gas and air, since it becomes possible thereby to have a steady flame with a relatively large quantity of primary air.

The University, Leeds. A. Smithells.

Gas for Heating and Lighting Laboratories.

I shall be greatly favoured if you will inform me which are the best "gas-making plants" for supplying a laboratory with gas derived either from coal, or paraffin oils.

Do you know anyone who has had experience of these? I more particularly incline to those easily managed and maintained, simple and inexpensive. Alex. Pardy.

Lynne House, Albyn Lane, Aberdeen, March 7.

If I were fitting up a large laboratory I should put in a small water gas generator and inject paraffin oil into the fuel during the period of steaming, fixing the hydrocarbons in the gas produced by passing through a superheater.

I see in the Journal of the Society of Chemical Industry for February 28 a paper by Masumi Chikashige, who had been fitting up the Kyoto University laboratory with a gas made in this way, and of which he gives the results, which appear to be very satisfactory. In the discussion upon the paper your correspondent will also find some useful hints as to the fitting up of laboratories with heating-gas where coal-gas is not available.

If he should not require enough gas to make a small carburetted water gas plant successful, and if he can get petrol or benzene, he will probably find carburetted air the cheapest thing to use. Vivian B. Lewes.

Royal Naval College, Greenwich, S.E., March 12.

Cooperation between Scientific Libraries.

As this subject has recently been receiving attention in Nature, it may interest some readers to know that the Royal Society of Edinburgh is taking steps for the purpose of finding out what can be done so far as the south of Scotland is concerned. A committee, of which I am convener, has been appointed by the council, and this committee is at present engaged in obtaining information from the various libraries of Edinburgh and Glasgow. It is hoped that later on a conference will be held, at which suggestions for joint action would be considered, and an endeavour made to draw up a scheme of cooperation for consideration by the various societies and institutions directly concerned.

I shall be very glad to supply information regarding the work of the committee to anyone who is specially interested in it, and also to receive particulars of any similar work which is being undertaken elsewhere.

Hugh Marshall.

University of Edinburgh, March 26.

THE PROBLEMS OF GEOLOGY.[1]

THIS admirably printed book deserves description rather than criticism, since the author, in his wide range of personal observation and reading, aptly plays the critic to the views that he successively propounds. With an unnecessary assumption of modesty, he apologises in his preface for "the clumsiness of a geologist, who is more at home with the hammer than the pen." We can scarcely believe that one who has tinged even his most serious scientific contributions with the high attraction of literary style can in reality know so little of himself. Almost all the papers in the present volume state a proposition and sustain an argument. There is, perhaps, a lighter one, describing a visit to the Lipari Isles; but even this contains a theoretical explanation of a difficult problem at the end. Yet the book is entirely readable, and will serve to bring to workers in all manner of fields the views of one who holds that nothing terrestrial is foreign to the subject of geology.

The papers are of various modern dates, and might, as we venture to think, have been brought nearer to uniformity in the text itself. Corrections are introduced in footnotes; but essays need not be treated as prize-poems, to be crowned with honour, and to remain unalterable. We do not want to read, for instance, that "the boring party is at this moment at work" on Funafuti, when evidence is immediately given that the task was completed seven years back. But this is a matter of pure detail; the scientific considerations put forward are uniformly fresh, vigorous, and inspiring.

The article on "The Age of the Earth" naturally brings us to no definite conclusion, seeing that the data on which a correct judgment depends are still of the scantiest description. A large number of readers, however, rejoice in such discussions; and we even discern grounds for combat when we are asked to believe that the opening of the fossiliferous stratified series lies only twenty-six million years behind us. In the following paper, on "The Figure of the Earth," we are introduced, as general readers, to Mr. Jeans's very recent hypothesis of a pear-shaped primitive earth, and a secondary pear-shaped earth with an equatorial bulge. Lest we should pin our faith to these or any other proposed forms, we shall do well to notice the excellently chosen language in which the author places them before us. In the discussion of the earth's loss of heat, radium is held up to us (p. 63) as "threatening to destroy all faith in hitherto ascertained results, and to shatter the fabric of reasoning raised upon them." Now and again, therefore, we suspect in Prof. Sollas the artist who feels in him a mission to produce and paint, even if in perishable pigments. The pigments are not his fault; they are all that others will provide for him; but the artist in him must find expression, spite of all. After this, dare we revert to the passage in the preface in excuse of "the clumsiness of a geologist"?

The summary of the results of the famous Funafuti boring is very welcome, especially in view of the cautious absence of generalisations that characterised the Royal Society report. It is a matter of regret that von Richthofen should have passed away without reading the authoritative re-vindication of his views as to reefs in Tyrol contained on pp. 131 and 132 of the present volume.

The sixth chapter, on "The Origin and Formation of Flints," should set at rest many fantastic theories still prevalent among amateur geologists. We only wish that the numerous flints of radiolarian origin could have been included in this lucid essay. Zoologists will be especially attracted by the next chapter, on "The Origin of Freshwater Fauna" (faunas?), in which Lake Tanganyika, among other areas, is discussed. William Smith's views on the contemporaneity of similar faunas are defended in "The Key to Terrestrial History"; and an address on "Geologies and Deluges," in which objection is properly taken to Suess's reliance on the Chaldæan narrative of the deluge, concludes the varied and uniformly interesting series.

If we accept "planctone"—but would the author write "gnomone"?—the only slips that we notice in this excellent book are in proper names, Burnett,

[1] "The Age of the Earth, and other Geological Studies." By W. J. Sollas, D.Sc., F.R.S. Pp. xvi+328. (London: T. Fisher Unwin, 1905.) Price 10s. 6d. net.

Huddleston, Birnham, and Mojsisoviks. The quotation from Tennyson on p. 233 has got astray, mainly in punctuation.

In conclusion, we would ask attention to the remarkable *tour de force*, or rather *tour d'esprit*, entitled "The Influence of Oxford on the History of Geology" (p. 219). In this, Plot's work as a "critic" is compared with that of Steno as a "prophet"; Kidd, an Oxford chemist, appears to be regarded as having furnished a serviceable brake to the wheels of Hutton's chariot; while Buckland's abandonment of the Noachian deluge as a geological factor, only to accept several deluges in place of it, is held up as a claim upon our gratitude. Here we think we see Prof. Sollas revelling in his mission as an artist; yet he paints far too frankly, and has no desire to deceive us. The pigments have been made in an ancient university; but we see right through the picture. We still prefer what we may consider as the first draft of this address, a modest pamphlet issued in Bristol in 1883, in which stress is laid on the progress of geological thought rather than on the benefits to be derived from its academic retardation.

FIG. 1.—The Sella Mass, Tyrol, the remains of a supposed ancient coral atoll. (From "The Age of the Earth, and other Geological Studies.")

THE NATIONAL PHYSICAL LABORATORY.

THE annual meeting of the general board of the National Physical Laboratory was held at Bushy House on Friday, March 16. There were present, in addition to the chairman, Lord Rayleigh, the following among others:—Sir John Wolfe Barry, Mr. Beilby, Mr. Kempe, Mr. R. K. Graye, Colonel Crompton, Mr. Hadfield, Mr. Gavey, and Mr. Howard.

In opening the proceedings, Lord Rayleigh referred to the great loss the laboratory had sustained by the deaths of Sir E. Carbutt and Sir B. Samuelson.

The report of the executive committee for 1905 was presented and approved for presentation to the Royal Society on the motion of Sir J. Wolfe Barry, seconded by Mr. David Howard. The scheme of work for 1906 was also approved. The report showed progress in all directions.

Some fourteen scientific papers of importance have been published officially, while members of the staff have contributed nine others to various journals.

The second volume of "Collected Papers" is in course of preparation. The scheme of work for 1906 includes a research into the resistance of materials of construction to impact, the continuation of the wind pressure and steam researches, the completion of the work with the Ampere balance, and some experiments of great interest on the effect of the continued application of high pressure to insulators. In the metallurgical division a research into the properties of aluminium bronze promises interesting results.

The report announced the intention of the Government, communicated to the Royal Society in December last, to grant a sum of 5000*l.* for buildings during the year, and the increase of the annual grant by 500*l.* It referred also to the very successful meeting in the House of Commons last August, under the chairmanship of Mr. Haldane, which led up to a petition, signed by 150 members of the House, asking that the grants should be increased, and the chairman was able to announce that the Chancellor of the Exchequer had recently intimated his intention of making the building grant for the year 10,000*l.* instead of 5000*l.*, as originally contemplated. We are able to add that this increase was largely due to an appeal to the Chancellor of the Exchequer by Mr. Haldane as president of the British Science Guild.

It was also stated that the Goldsmiths' Company had very generously made a donation of 1000*l*., with the request that it should be devoted to some specific object.

The very cordial thanks of the board were voted to the Chancellor of the Exchequer, Mr. Haldane, Sir J. Lawrence, Sir J. Brunner, and the other gentlemen who had interested themselves in the House of Commons petition, and also to the Goldsmiths' Company.

The director gave an account of the proposed additions to the buildings rendered possible by the increased grant, and explained the plans which had been prepared by the building committee. The suggestion that the work of erecting these buildings should now be pressed forward was cordially welcomed, and at a meeting of the executive committee held later power was given to the building committee to take the necessary steps. The board then adjourned to inspect the laboratory and to view the new electrical buildings, which are now approaching completion. They have been erected by Messrs. Mowlem and Co., at a cost of about 8000*l*., to the design of Messrs. Mott and Hay, who very kindly gave their services, while with marked generosity Messrs. Mowlem's tender was based on the cost price of the buildings.

It is hoped that they may be opened on June 25 on the occasion of the visit of the foreign guests of the Institution of Electrical Engineers. In view of this ceremony the invitations on March 16 were restricted to members of the board and their personal friends, the usual annual gathering of friends of the laboratory being postponed until June.

NOTES.

A PRELIMINARY programme has been received of the events in connection with the Franklin bi-centenary, which the American Philosophical Society will celebrate at Philadelphia on April 17–20. The opening ceremony will take place on April 17, when the president, Prof. Edgar F. Smith, will deliver an address. Numerous papers on subjects of science will be read on April 18 by distinguished American men of science. In addition to these, Sir George Darwin, K.C.B., F.R.S., will read a paper on the figure and stability of a liquid satellite, and Prof. Hugo de Vries, of Amsterdam, will deal with elementary species in agriculture. Addresses will be given during the evening of the same day by Prof. E. L. Nichols, on Franklin's researches in electricity, and Prof. E. Rutherford, F.R.S., on the modern theories of electricity and their relation to the Franklinian theory. On April 19 honorary degrees will be conferred by the University of Pennsylvania, and an oration will be delivered by the Hon. Hampton L. Carson, Attorney-General of Pennsylvania. Ceremonies will be performed on this day at the grave of Franklin. On April 20 addresses in commemoration of Franklin will be given by Dr. H. H. Furness, who will speak of him as citizen and philanthropist; Dr. C. W. Eliot will pronounce a eulogy of him as printer and philosopher; and Dr. J. H. Choate as statesman and diplomatist. The presentation of the Franklin medal to the Republic of France, in accordance with the Act of Congress, will be made by the Hon. Elihu Root, Secretary of State.

DR. LIBBERTZ, the scientific director of the bacteriological department of the Farbwerke, Hochst a. M., is going to South Africa with Dr. Robert Koch to study the question of sleeping sickness.

WE learn from the *British Medical Journal* that the donations to the fund being collected for the establishment of an Institute of Cancer Research in connection with the University of Heidelberg now amount to 34,000*l*.

AN exhibition devoted to engineering and mechanical appliances will be held at Olympia from September 15 to October 17. Sir William White, K.C.B., is president, and the list of patrons includes the presidents of the various engineering societies. The offices of the exhibition are at Balfour House, Finsbury Pavement, London.

THE eighth International Agricultural Congress will be held in Vienna on May 21–25, 1907. The proceedings of the congress will be carried on in eleven sections, of which section ii. will be devoted to questions on instruction in agriculture and forestry, section vi. to agricultural industry, section vii. to the protection of plants, and section x. to vine growing, &c.

A REUTER telegram states that M. Mylius Erichsen's Danish expedition to the north-east coast of Greenland will leave Copenhagen at the end of June, and will proceed *viâ* the Færöe Islands and east Iceland to the east Greenland pack-ice, through which the explorer expects to be able to penetrate into East Greenland between 57° and 77° northern lat. In addition to the Danish members, the exploring party will probably include Dr. A. Wegener, from Germany, as physicist and meteorologist, and Dr. Baron Firchs, from Russia, as geologist.

ACCORDING to a Reuter message from Peshawar, a letter from the Governor of Balakh states that while some peasants were preparing their land for cultivation they came upon some ruins, which on further examination proved to be wall enclosures of a ruined city. The Governor visited the spot, and found the ruins of a large city, with some gold coins, the inscriptions on which nobody could read. Old Afghans said they had heard from their ancestors that a large Kafir (or infidel) city existed in the vicinity, which had been destrŏyed long since, and that in the ruins were buried the treasure of the Kafir kings. Some of the coins were sent to the Ameer for inspection.

THE Washington correspondent of the *Times* states that the report of the American members of the International Commission for the Preservation of the Niagara Falls recommends that legislation be passed, based on a treaty between America and Canada, to prevent further depletion of the water, to maintain the present scenic effects, and to regulate the electrical supply companies which are using the Falls for power. It is proposed to limit the diversion of the waters on the American side to 28,500 cubic feet a second, and the diversion on the Canadian side to 36,000 cubic feet. This advantage of Canada is in reality only on paper, as the power generated on the Canadian side is used largely in the United States. The report states that the diversion of water by works already authorised is likely to injure the Falls, and will possibly leave the American fall dry. It is estimated, however, that five-sixths of the total of 60,900 feet a second authorised chiefly affects the Canadian Horseshoe Falls.

MR. FRANK STROMSTEN gives a good account of the anatomy and development of the venous system of various species of turtles (*Amer. Journ. of Anatomy*, iv., 1905, p. 453). About forty turtles of the more common species were dissected, and fifty turtle embryos were studied for the development of the veins. In general, the development of the veins of the hepatic and renal portal systems is the same in turtles as in lizards and snakes, but there are important differences.

SCIENCE BULLETIN No. 7 of the Brooklyn Institute contains an account by Mr. C. Schaeffer of beetles new to the United States, and also a description, by Dr. H. G. Dyar, of new moths from Arizona. Among the latter use is made of the generic name Janassa, usually applied to a group of Palæozoic fishes. The marine ostracod crustaceans of Vineyard Sound form the subject of a paper by Mr. J. A. Cushman in the Proceedings of the Boston (U.S.A.) Society of Natural History, vol. xxxii., No. 10.

THE results of a study of the wing-structure of the hymenopterous insects of the group Tenthredenoidea, published in No. 1438 of the Proceedings of the U.S. National Museum, have enabled Mr. A. D. MacGillivray to demonstrate the origin of the modern complex hymenopterous wing from one of the simplest type. Throughout the line of evolution all the modifications have tended to render the wing more efficient as an organ of flight, this efficiency being due to the arrangement of the veins in such a manner as to stiffen the areas subjected to the greatest strain.

IN the *Verhandlungen* of the German Zoological Society for 1905 Prof. Simroth discusses the geographical distribution of land-shells, salamanders, and ganoid fishes, more especially in connection with climatic changes due to precession of the equinoxes; while Dr. K. Guenther contributes a review of theories and facts bearing on bird-migration. Special interest attaches to an article by Dr. O. Abel on the phylogenetic evolution of the cetacean dentition and the systematic relations of the Physeteridæ. Both physeteroids and ziphioids are considered to have originated, independently, from squalodonts during the Miocene, while the latter are connected with the true Eocene zeuglodonts by means of Microzeuglodon. If this phylogeny be well founded, we may accept the descent of cetaceans from creodont carnivores.

AMONG the contents of part ii. of the third volume of the quarterly issue of the Smithsonian Miscellaneous Collections is a paper on the great whale-shark (*Rhinodon typicus*), by Mr. B. A. Bean, in which figures are given of the type specimen taken at the Cape in 1828, and of an individual recently stranded on the Florida coast. This shark is stated to grow to a length of 60 feet, and is thus the next largest animal to the biggest kinds of whales. Like its relative the northern basking shark, it has a terminal mouth and feeble dentition, and is quite harmless to man. In a second article Mr. W. H. Osgood describes remains of certain ancestral musk-oxen from Alaska and other parts of Arctic America, while in a third Mr. T. Gill furnishes a very interesting account of the carp group. In the course of a paper on Mexican land-shells, Dr. W. H. Dall describes a new genus, Hendersonia, remarkable for having developed a multispiral discoid shell, with an upturned mouth, quite unlike those of its relatives.

IN the Bulletin of the Johns Hopkins Hospital for February (xvii., No. 179) the biographical sketches of medical worthies of former times, which have formed a marked and interesting feature of recent issues, are continued, the subject of this month's sketch (by Dr. Walter Steiner) being the Rev. Gershom Bulkeley, of Connecticut, born about 1635, who, having served in the ministry, was obliged to resign owing to weakness of voice, and subsequently devoted himself to the practice of medicine. Articles of medical interest, reports of societies, &c., complete the number.

IN his presidential address to the Entomological Society of London, Mr. F. Merrifield surveyed the results obtained by other investigators and himself in studies of the influence of temperature and other conditions on insects. As a result of artificial experiments, it has been found that alteration of temperature on developing insects affects to some extent the colouring of the adults. Apparently high and low temperatures do respectively make the insects tend to approximate in colouring to warmer temperate and arctic types.

THE issue of the Philippine Journal of Science, the first number of which (January) has reached us, is further proof of the manner in which scientific research is being cultivated by the American Government. The journal is well printed on paper 10 inches by 7 inches, and contains several excellent illustrations. The editors are Dr. Paul Freer and Dr. Richard Strong and Mr. H. D. McCaskey, and the contents of the present number are three articles on the cocoa-nut palm and oil, by Dr. Freer, Mr. E. B. Copeland, and Mr. H. S. Walker respectively; the occurrence of *Schistosoma japonicum* vel. *Cattoi* (a parasite fluke) in the Philippines; and a study of some tropical ulcerations of the skin, by Dr. Strong.

PROF. ADAMI discusses in an interesting paper the question of the transference of bovine tuberculosis to man through milk (*Amer. Medicine*, ix., 1905, p. 683). He holds that such conveyance is not so frequent as is generally accepted (von Behring goes so far as to attribute most human tuberculosis to the use of tuberculous milk in infancy). Kitasato has recently published statistics of the incidence of tuberculosis in Japan, which show that the deaths from tuberculosis in Japan are just about in the same proportion to the total deaths and to the total population as are the deaths from this disease in European countries; but primary intestinal tuberculosis in the young (which has been attributed to the ingestion of tuberculous milk) is rather more prevalent (30 per cent. of the total) than in Europe and America (25 per cent.). The use of cows' milk for feeding infants is unknown in Japan, and Prof. Adami therefore holds that the facts gathered in Japan show that intestinal tuberculosis, which is as frequent there as in Europe, cannot be attributed to the ingestion of infected cows' milk, and cannot therefore be of bovine origin; and the inevitable conclusion is that if intestinal tuberculosis is moderately frequent, and not of bovine origin, then similarly a large proportion of European intestinal tuberculosis is in all probability not due to infection from milk.

Two leaflets referring to British East Africa have been received; of these, leaflet No. 12 of the Department of Agriculture, Nairobi, provides a list of forage plants with their special characteristics, and leaflet No. 2, issued by the Forest Department, deals with native trees. The list of native trees, with vernacular names and uses, is accompanied by a few hints as to the selection of suitable species, the collection of seeds, and the methods of planting.

THE Kew Bulletin for the year 1900 (Nos. 178–180) reached us a few days ago! The Bulletin, which has been in abeyance since the volume for 1901 was completed—with the exception of a part issued as No. 1, 1905—was re-inaugurated with a part recently published as No. 1, 1906. This number is devoted entirely to descriptions of new specimens, the contents being "Decades Kewenses, xxxvi.–xl.," "Diagnoses Africanæ, xiv.," and "New Orchids, Decade 26." The first furnishes a list of ferns and flowering plants, of which the majority were collected by Dr. Henry in China. An interesting species is *Cuscuta Upcraftii*, that has been grown on potatoes from seed collected in Tibet by Mr. W. M. Upcraft. A list of staffs in botanical departments at home, in India, and the colonies has also been published as Appendix iv., 1905.

AN interesting report on the mineral resources of the Kalahasti Zamindary, Madras, has been published by Mr. V. S. Sambasiva Iyer, of the Mysore Geological Department (Bangalore, 1906). Gold, iron ore, barytes, and marble are met with. The evidences obtained and the records of old workings fully justify a detailed prospecting of the Sirasinambedu gold deposits.

IN the *Engineering Magazine* for March there is an admirably illustrated account of gypsum mining in the vicinity of Paris by M. Jacques Boyer. Interesting details are given of the calcination of the material and of the preparation of plaster of Paris. At the present time some eighty companies are engaged in the industry near Paris, and 5500 workmen are employed.

A REMARKABLE example of the surface outcrop of an iron ore deposit is illustrated in an article on iron ore in Mexico, by Mr. R. H. Anderson, in the *Engineering and Mining Journal* of New York (vol. lxxxi., No. 9). The deposit is situated on the Las Truchas creek, near the boundary of the States of Michoacan and Guerrero. The outcrop is 10,000 feet in length and 4000 feet wide. It rises to a height of 450 feet.

THE paper on smoke prevention contributed by Mr. A. J. Martin to the conference on smoke abatement at Westminster in December, 1905, has now been published in pamphlet form (London: Sanitary Publishing Co., Ltd., price 1*s*.). Mr. Martin advocates a scheme of long-distance gas transmission, and urges that a strong permanent committee be appointed by the Government to deal with the evils produced by smoky fogs, and the desirability of providing a cheap, smokeless fuel for domestic and industrial use.

THE opening number of vol. iii. of the *Bolletino* of the Italian Meteorological Society contains an interesting article on the supposed connection between rainfall and volcanic activity, unsigned, but evidently emanating from the Observatory of Catania. The author finds that whether account is taken of the daily variation in the activity of Etna during the eruption of 1892, or the whole series of eruptions the date of which is known with accuracy, there is no evidence of any connection between the volcanic activity of Mount Etna and the local rainfall; neither of these determines or is determined by the other.

THE weather during the past week has been unusually cold and disagreeable over the whole of the British Islands, the day temperatures being about 10° below the average for fifty years, with sharp frost at night, and frequent showers of snow and hail. These conditions were produced by a complex distribution of barometric pressure, the chief features of which were an anticyclone lying over the Atlantic at some distance to the west of our shores, with areas of low pressure over Germany and the south-west of France, and they were consequently accompanied by bitter northerly and north-easterly winds, whilst gales were experienced on several coasts. The following low night screen temperatures have been reported to the Meteorological Office:—22° in the Midland counties and 23° in the south of England. At Greenwich the exposed thermometer fell to 18° on the morning of March 23. Sunshine exceeded the normal amount in several districts.

THE University of Innsbruck publishes in a concise and handy form the results of the observations made at its meteorological observatory, situated about 1886 feet above the sea. The last pamphlet received contains observations and mean results for 1902, taken three times a day, together with hourly values from various self-recording instruments. The tables have been prepared by Dr. W. Trabert, which is a sufficient guarantee for the accuracy of the work. There is a useful appendix by Mr. H. von Ficker on cloud formation in the Alpine valleys from observations extending from January, 1904, to March, 1905, with valuable notes on the occurrence and behaviour of the Föhn wind. This phenomenon is well known to Alpine observers as, generally speaking, a dry, warm wind, to the influence of which the melting of the snow in the spring is chiefly due.

THE current number of the *British Journal of Psychology* (vol. i., part iv.) contains as its main feature an article by Dr. W. H. R. Rivers entitled "Observations on the Senses of the Todas," a small and possibly degenerating community of about 800 individuals, living among the Nilgiri Hills in southern India. The methods of observation were similar to those used by the Cambridge expedition to the Torres Straits. Visual acuity, colour-vision, visual illusions, tactile discrimination, tactile illusions, sensibility to pain, smell, taste, hearing, were all made the subject of tests. Of these the most elaborately treated are visual illusions, particularly the illusion of compared horizontal and vertical lines, and Dr. Rivers puts the results obtained from the Todas in this department of observation alongside those obtained from Cambridge undergraduates. In his general conclusions he lays stress on the difference in the part played by inference in the process of determining the sensory threshold, and the consequent difficulty of comparing sense-acuity in races of different culture. This play of inference reaches its greatest scope in the case of smell. In visual acuity and the tactile acuity of the forearm it would appear that the Todas have a slighter degree of sensibility than more civilised races, but they are inferior rather than superior in acuity of smell, and probably in acuity of hearing; they are also less sensitive to pain. Among other articles are those of Dr. James Ward, "Is 'Black' a Sensation?" and of Mr. W. McDougall, on "The Illusion of the 'Fluttering Heart' and the Visual Functions of the Rods of the Retina." Mr. McDougall points out that two quite distinct illusory appearances have been hitherto confused and brought together under the designation "the fluttering heart," and he claims that the true explanation of one of these is to be found in a suggestion made by Prof. J. von Kries.

IN the *Chemiker Zeitung* for March 21 is an interesting report, by Dr. E. Gerlach, dealing with the advances made by electrotechnical industries during last year. The writer deals particularly with electrical illumination, telegraphy and telephony, new accumulators, dynamo machines, electrical heating, power transmission, electrical railways, conductors and insulators, and measuring instruments.

As is well known, the carbides of different metals yield different hydrocarbons when acted upon by water. Thus while calcium carbide gives acetylene, aluminium carbide produces marsh gas (methane). We learn from the *Zeitschrift für Elektrochemie* (vol. xii., p. 20) that in St. Alban, France, a carbide is now being manufactured from which ethylene is evolved when it is acted upon by water. The ethylene so obtained is pumped into sulphuric acid, by which it is absorbed with production of ethyl hydrogen sulphate. Now when ethyl hydrogen sulphate is acted upon by water, alcohol and sulphuric acid are produced. By distillation the alcohol can be obtained free from the sulphuric acid, and the sulphuric acid can again be obtained in the concentrated condition by evaporation. Furthermore, the metallic oxide which is used in the production of the carbide is again obtained when the carbide is acted upon by water, so that the production of alcohol is summed up in the equation carbon+energy=alcohol. Up to the present it has been found necessary to use four times the quantity of carbon which should theoretically be required. How much more energy it is necessary to employ than is required by the theory is not stated. We remember that so far back as 1893, when the calcium carbide industry was in its infancy, it was suggested that the acetylene might by reduction with hydrogen be converted into ethylene, and the ethylene so obtained be employed for the manufacture of alcohol. In fact, we believe that several patents were taken out upon the subject. Owing to the difficulty of reducing acetylene, the process could hardly be expected to be a success. In the present case, however, provided the formation of the carbide is not too costly and the recovery of the sulphuric acid and metallic oxide not too expensive, the process seems to possess at any rate the elements of success.

THE first part has been received of an "Atlas of the World's Commerce," by Mr. J. G. Bartholomew, which is to be published by Messrs. George Newnes, Ltd., in twenty-two parts. The parts, which cost 6*d*. each net, are to appear fortnightly.

MR. DAVID NUTT has issued a ninth edition of the late Prof. A. Milnes Marshall's well known book on "The Frog: an Introduction to Anatomy, Histology, and Embryology." The work has been edited by Dr. F. W. Gamble, who has revised the chapter on development and added some figures.

A NEW monthly periodical, entitled *Science and Technology*, price sixpence net, has just appeared. It is intended to be of interest and assistance to teachers and students. The first number contains articles dealing with educational administration, examination syllabuses, and reports of meetings. The only contribution of a wholly scientific character is a reprint of Prof. S. P. Thompson's lecture at the Royal Institution on the electric production of nitrates from the atmosphere.

A THIRD edition of Sir William Ramsay's "Gases of the Atmosphere. The History of their Discovery," has been published by Messrs. Macmillan and Co., Ltd. The first edition of the book, published in 1896, included a non-technical description of argon, discovered in the atmosphere in 1894. To the second edition of 1900 a new chapter was added describing the other four inactive gases discovered to be present in air—helium, separated from the atmosphere in 1900, and neon, krypton, and xenon, discovered in 1898, and separated from argon and from each other during 1899 and 1900. The present edition has also been enlarged by the addition of another chapter, this one treating of the radio-active gases produced by the disintegration of radium and radium-thorium, which have been added recently to the list of constituents of the atmosphere.

OUR ASTRONOMICAL COLUMN.

COMET 1906*c*.—From observations made on March 19, 20, and 21, Dr. Strömgren has computed the following elements and ephemeris for the comet discovered by Mr. Ross on March 18:—

Elements.

$$T = 1906 \text{ Feb. } 22{\cdot}216 \text{ Berlin M.T.}$$

$$\left.\begin{array}{l} \omega = 281^\circ\ 24'{\cdot}1 \\ \Omega = 73^\circ\ 2'{\cdot}1 \\ i = 80^\circ\ 34'{\cdot}0 \end{array}\right\} 1906{\cdot}0$$

$$\log q = 9{\cdot}88336$$

Ephemeris 12h. M.T. Berlin.

1906	α (h. m. s.)	δ (° ′)	log Δ	Brightness
Mar. 29	2 38 33	+ 4 11·5	0·2356	0·63
April 2	2 48 40	+ 7 38·4	0·2547	0·53
6	2 58 9	+10 47·5	0·2732	0·44

(*Kiel Circular*, No. 87.)

OBSERVATION OF COMET 1905*c* AFTER PERIHELION.—A letter received from Prof. H. R. Morgan (Glasgow, U.S.A.) by Prof. Pickering states that the former observed Giacobini's comet, 1905*c*, on February 21, that is, since it appeared to the east of the sun.

The comet's apparent position at 7h. 40m. 44s. (Glasgow M.T.) was α=1h. 8m. 29·2s., δ=−11° 9′ 11″, which gave corrections of −11s. and −3′·4 to Herr Wedemeyer's ephemeris on the date of observation (*Astronomische Nachrichten*, No. 4079).

NEW VARIABLE STARS IN THE REGION ABOUT γ SAGITTÆ.—From the comparison of several photographs taken with the Bruce telescope, Prof. Wolf has discovered fifty-five new variable stars in the region about γ Sagittæ.

In No. 4079 of the *Astronomische Nachrichten* he gives the details concerning the discovery and measurement of each star, and, in addition, a list showing the position (1855·0) and the magnitude on various dates between 1900·7 and 1905·7. Forty-seven circular charts which accompany the paper show the region immediately surrounding each variable.

THE SUPPOSED NEBULOSITY AROUND NOVA AQUILÆ NO. 2.—In the opinion of Prof. Frost, the suggestion that the nebulous appearance of images of Nova Aquilæ No. 2 is entirely due to chromatic aberration is the correct one.

Plates taken with the 24-inch *reflector* at Yerkes Observatory on September 21 and 27, and October 23, 1905, show no nebulosity, whilst Prof. Wolf has obtained similar effects to this apparent nebulosity with other stars having peculiar spectra. A third argument against the phenomenon being due to true nebulosity is that, in order to produce the image obtained, the intrinsic brightness would have to be at least 1800 times as bright, in proportion to the light of the star, as that of the nebula known to exist around Nova Persei (*Astronomische Nachrichten*, No. 4079).

SOME TESTS OF THE SNOW TELESCOPE.—A very interesting note by Prof. Hale, published in No. 1, vol. xxiii., of the *Astrophysical Journal*, describes the present condition, and some tests, of the large Snow telescope which has been erected at the Solar Observatory, Mount Wilson.

The greatest inconvenience encountered in the early use of this instrument was in connection with the spectroheliograph work. Three mirrors are employed, of which the first, the 30-inch cœlostat mirror, reflects the solar rays on to a 24-inch plane mirror, which in turn directs the beam on to the 24-inch concave mirror of 60-feet focus, which forms the image of the sun on the primary slit.

When the instrument was used, with a high sun, on a hot, windless day, it was found that a serious change of focus, amounting in some cases to 12 inches, occurred, and, worse still, the mirrors became distorted, giving a difference of focus for the opposite limbs of the image of as much as 3 inches.

On days when a cool breeze blew across the surface of the mirror the change was less, so arrangements have now been made to send a current of air across the face of each mirror between the exposures, by means of fans.

Prof. Hale has found that an hour after sunrise is the best time for solar work, and after that an hour before sunset.

Experiments are being carried out for the purpose of discovering some good substitute for glass in mirror making. "Invar" has proved to be too soft, and the fused quartz discs have not been a success. Prof. Hale suggests that speculum metal will be found to answer the purpose better than glass.

Photographs taken with the Snow telescope have proved better than those obtained with the 40-inch refractor at Yerkes, and Prof. Hale states that, from a mechanical standpoint also, the telescope has proved completely successful.

STUDIES ON THE SYNTHESIS OF PEPTIDES AND PROTEIDS.[1]

AMONG the many brilliant achievements in synthetic chemistry accomplished by Prof. Emil Fischer during the last quarter of a century, none have surpassed in interest the remarkable series of researches which formed the subject of a recent address to the German Chemical Society.

In reading this address it is impossible to say which commands greater admiration, the author's consummate skill and endless resource in sweeping aside each difficulty as it arose in a most intricate field of experimental inquiry, or his intense and ceaseless activity in producing almost month by month during the past five years a wealth of new knowledge of the very first importance to biological science.

"Whilst our cautious colleagues," says Prof. Fischer, "fear that a systematic study of this group of compounds (the proteids) will be beset with endless difficulties on account of their troublesome physical features, there are others, among whom I count myself, who are more optimistic, and hold that an attempt at least ought to be made with every modern appliance to lay siege to this unconquered citadel; for it is only by a bold attempt that the limitations of our present methods can be adequately gauged."

The success which has so far attended Prof. Fischer's first attack promises a speedy capitulation. The proteids will then be made to deliver up the key to their molecular structure, and the first real advance in biochemistry will have been accomplished.

Although physiological chemistry has done much in the past in the way of classifying the numerous members of the proteid group, in preparing a few members in the crystalline form, in attaching to different individuals different biological functions, and in ascertaining the fundamental changes effected by ferment action, our knowledge of their chemical constitution has up to the present been extremely meagre. Apart from the percentage composition, it is limited mainly to the results of hydrolysis by acids, alkalis, or digestive ferments. When submitted to these agents all proteids yield successively albumoses, peptones, and, finally, amino-acids. Of the nature of the first two we are but little better informed than of that of the proteids themselves.

The study of the amino-acids has been attended with more success, for not only has the structure of the majority of them been ascertained, but many have been prepared synthetically. The following is a list of amino-acids obtained by hydrolysing one or other of the natural proteids:—

Glycine	Serine (α-amino-β-hydroxy-propionic acid)
Alanine	Tyrosine
Aminovaleric acid	Tryptophane (skatolamino-acetic acid)
Leucine	Lysine
Isoleucine	Arginine
Phenylalanine	Histidine
Glutamic acid	Diaminotrihydroxydodecanic acid
Aspartic acid	Diaminoglutaric acid
Cysteine	Diaminoadipic acid
α-Pyrrolidine carboxylic acid (proline)	Hydroxyaminosuccinic acid
Hydroxy-pyrrolidine carb-oxylic acid (oxypyroline)	Dihydroxyaminosuberic acid

1 *Vide* Address by Prof. Emil Fischer, "Untersuchungen über Aminosäuren Polypeptide und Proteine" (*Berichte der deutschen Chem. Gesell.*, 1906, xxxix., 530.)

It was to the study of these acids—the fragments, so to speak, of the albumin molecule—that Fischer first directed his attention, hoping ultimately by piecing them together to construct the simplest of the albumins. In the synthesis of the monoamino-acids Fischer has added to the methods already known that of brominating the alkyl malonic esters and then converting the corresponding acid into the α-bromo-fatty acid, which with ammonia yields the amino-acid. He has, moreover, devised an ingenious process for resolving the synthetic, and, consequently, inactive compounds into their active components. The amino-acids are such weak acids that they refuse to form crystalline salts with the active alkaloids. By converting them into the benzoyl or formyl derivatives, strong acids are produced which may be easily resolved by the ordinary process of fractionally crystallising the salts of the active bases. The diamino-acids, such as ornithine (αδ-diaminovaleric acid) and lysine (αε-diaminocaproic acid), both common products (the former as arginine) of proteid hydrolysis, have also been synthesised by Fischer by adapting Gabriel's reaction in one case and that of Blank in the other. Gabriel's phthalimidopropylmalonic ester, when brominated, gives a monobromo-derivative, which is then hydrolysed and heated to remove one carboxyl group, the resulting compound being phthalimidobromovaleric acid,

$$C_6H_4\left\langle\begin{matrix}CO\\CO\end{matrix}\right\rangle N.CH_2.CH_2.CH_2\,CHBr.COOH.$$

This was converted into the amino-derivative, and by splitting off the phthalyl radical the racemic form of natural ornithine was obtained,

$$NH_2.CH_2.CH_2.CH_2.CH(NH_2).COOH.$$

The starting point for the preparation of lysine was Blank's γ-cyanopropylmalonic ester,

$$CN.CH_2.CH_2.CH_2.CH(COOC_2H_5)_2,$$

which is converted by nitrous acid into α-oximino-δ-cyanovaleric ester,

$$CN.CH_2.CH_2.CH_2C(:NOH).COOC_2H_5.$$

The latter, on reduction, yields the racemic form of lysine (αε-diaminocaproic acid). The synthesis of hydroxyamino-acids such as serine of silk fibroin has also been accomplished by applying Strecker's reaction to the hydroxy-aldehydes. Thus ammonia converts the cyanhydrin of glycollic aldehyde into the aminocyanhydrin which on hydrolysis yields inactive serine,

$$CH_2(OH).CHO \rightarrow CH_2(OH).CH(OH).CN \rightarrow$$
$$CH_2(OH).CHNH_2.CN \rightarrow CH_2(OH).CHNH_2.COOH.$$

Of no less importance to the solution of the albumin problem have been the new methods furnished by Fischer for the separation and identification of the products of proteid hydrolysis, for a correct knowledge of the varied compounds which compose the albumin molecule must necessarily precede any attempt to effect its synthesis. Foremost among these stands the "ester method." It consists in converting the mixture of amino-acids, obtained on hydrolysis, into the corresponding esters, which are then submitted to fractional distillation under very much reduced pressure (10–15 mm.). The method cannot, however, be conveniently applied to the separation of tyrosine or the diamino-acids, which are treated in a different fashion. Space does not permit of more than a passing reference to the formation of benzoyl, formyl, and β-naphthalene sulphonyl derivatives, and of the phenyl hydantoins obtained with phenylisocyanate, all of which have been utilised either in the purification or identification of the amino-acids. We must leave this part of the subject in order to follow Prof. Fischer into the more attractive field of constructive research, and examine the plans which he has laid for attacking the synthetic side of the problem. Simply stated, the object he has had in view has been to link together two, three, four, or more molecules of those amino-acids which the proteids yield on hydrolysis, and by varying the combinations to obtain eventually something resembling the peptones or the simplest albumins. To these artificial combinations of amino-acids Fischer has given the name of *polypeptide*, or, according to the number of single amino-acid groups present, di-, tri-, tetra-, &c., peptide. This view of the constitution of proteid matter, which seemed at the outset of the investigation warranted by the nature of the evidence then forthcoming, received ample justification by the very recent isolation of the first natural dipeptide in the process of hydrolysing silk fibroin. But we are anticipating matters. The first of the polypeptides was obtained by Curtius in 1882, but as its structure is complex and has only been lately ascertained, we will begin with the simpler members prepared by Fischer.

In 1901 Fischer and Fourneau found that glycine anhydride, which, according to Curtius, is formed when glycine ester is heated in aqueous solution, is partly hydrolysed with mineral acids into glycylglycine, the first and simplest of the dipeptides,

$$NH\left\langle\begin{matrix}CH_2.CO\\CO.CH_2\end{matrix}\right\rangle NH + H_2O = NH_2.CH_2.CO.NH.CH_2.COOH.$$

A year later Fischer found that a third amino-acid or peptide group could be linked to the carbethoxy-derivative of glycylglycine (prepared by the action of chloroformic ester on the dipeptide) by heating it with leucine ester, whereby carbethoxyglycylglycyl-leucine ester resulted, which on hydrolysis is converted into the free acid,

$$C_2H_5CO_2.NH.CH_2.CO.NH.CH_2.CO.NH.CH(C_4H_9)CO_2H.$$

The next year saw the introduction of a new method for adding fresh links to the peptide chain by the use of thionyl chloride. This effects the conversion of the end carboxyl group into the acid chloride, and it thus became possible by the subsequent action of an amino-ester to add a new peptide group to the molecule. Thus carbethoxyglycylglycine was converted successively into the acid chloride, and then by the action of glycine ester into carbethoxydiglycylglycine ester, and by a repetition of the process into carbethoxytriglycylglycine ester. Similar compounds with different amino-acids were obtained by this reaction. In all of them, however, the carbethoxy-group at the amino end of the chain refused to be removed, and a new method had to be found for preparing the free polypeptides. This was soon forthcoming. In 1903 Fischer and Otto introduced the chloracyl chlorides for the purpose. Glycylglycine ester was first combined with chloracetyl chloride, hydrolysed, and warmed with ammonia, whereby diglycylglycine was formed,

$$ClCH_2.COCl + NH_2.CH_2.CO,NH.CH_2.COOR = ClCH_2.CO,NH.CH_2.CO,NH.CH_2.COOR + HCl.$$

$$ClCH_2.CO,NH.CH_2.CO,NH.CH_2.COOH + NH_3 = NH_2.CH_2.CO,NH.CH_2.CO,NH.CH_2COOH + HCl.$$

This method proved extremely fruitful, and led to the production of a variety of di-, tri-, tetra-, and penta-peptides.

It will be easily conceived how the methods just described afford the means of lengthening the peptide chain at either end. In the one case an α-chloro- or bromo-acyl chloride is added to the amino-group at one end, or, at the other, the carboxyl group is converted into the acid chloride, for which purpose thionyl chloride has since been replaced by phosphorus pentachloride dissolved in acetyl chloride. In the first case the action of ammonia, in the second that of an amino-acid or another peptide (the ester is not necessary) in presence of alkali, produces the new peptide. By combining the two processes, hexa- and hepta-peptides giving the biuret reaction have been formed from diglycylglycine, and Prof. Fischer confidently predicts the synthesis of still longer chains. In the present year Fischer has also found that two molecules of the methyl ester of diglycylglycine can by heating be combined into the ester of pentaglycylglycine, which yields the hexa-peptide on hydrolysis.

If the proteids themselves and the amino-acids to which they give rise comprised optically inactive members, the experimental difficulties in the way of synthesis might be looked upon as approaching solution; but few of the natural products are inactive, and the question of preparing by artificial means active polypeptides must be faced. This part of the problem has not been neglected. By resolving the amino-acids into their active constituents before linking them together, or by submitting certain inactive members to the selective fermentation of pancreatic juice (for trypsin acts upon some of the polypeptides as it does on proteids), active polypeptides have been obtained.

In addition to the action of trypsin, the polypeptides exhibit many characteristics of the simpler proteids; they are for the most part soluble in water; especially is this the case where the peptide is composed of different amino-acids; they are insoluble in alcohol, and many of the higher members give the "biuret" reaction. Like the proteids, also, they are quickly and completely hydrolysed by strong hydrochloric acid into amino-acids; the action of dilute hydrochloric acid and caustic alkalis is, on the other hand, very slow.

The concluding sections of the address will appeal more especially to physiologists, for they deal with the products of hydrolysis of the proteids themselves. Space will not permit of more than a passing reference to them; the reader who is interested in the products obtained by the action of pancreatic juice or the combined action of pepsin, hydrochloric acid, and pancreatin must refer to the original memoir. It may, however, be stated that pancreatin yields, in addition to numerous monoamino-acids, a product which does not give the biuret reaction, but shows a certain resemblance to the artificial polypeptides, and breaks up on hydrolysis with acids into alanine, leucine, glutamic and aspartic acid, as well as proline and phenylalanine. By the successive pepsin and pancreatin digestion the amount of this polypeptide body is diminished, but in its place proline and phenylalanine appear.

As many of the commoner forms of proteid matter behave in this way, Fischer concludes that proline is an actual constituent of the proteid molecule. For similar reasons he includes tyrosine, leucine, alanine, tryptophane, &c., which always appear in the pancreatic digestion of albumin, a view which is supported by the action of pancreatic juice on the artificial polypeptides containing these groups. But of all the facts which point to the polypeptide nature of the albumins, the most convincing is Fischer and Abderhalden's latest discovery of a dipeptide in silk fibroin, which they have identified as glycyl-*d*-alanine. The method of preparation is interesting, because it introduces the new principle of combining acid with pancreatic hydrolysis. The silk fibroin is first digested with 70 per cent. sulphuric acid for several days at 18°, then diluted with water, the acid removed with baryta, and the liquid evaporated and submitted to the action of pancreatic juice for eight days. The tyrosine which had then separated was removed, and the esters of the amino-acids were formed in the usual way and heated under reduced pressure at 65° to remove the alcohol and a little glycine and alanine ester.

From the syrupy residue dissolved in alcohol and saturated with ammonia gas (to convert the dipeptide ester into the diketopiperazine), a crystalline precipitate of glycyl alanine anhydride slowly separated. Fischer sees in this discovery a near prospect of obtaining the most important constituents of the natural peptones, and even of the albumoses, and of reproducing them artificially. "But the problem of reproducing true albumins," says Fischer, "is of far greater difficulty, for their reconstruction from the first products of hydrolysis (peptones and albumoses) will require entirely novel methods, and when these are found their application will probably be a laborious process. One may therefore ask the question whether the eventual success will compensate for the labour expended. This depends, in my opinion, on the profit which biological research can derive from it, and this, again, on the manner in which the synthesis has been accomplished. For such a synthesis may be compared to a tourist who rushes through a country in an express train and sees nothing. It is otherwise if the synthesis is constrained to advance slowly and to construct the molecule step by step. It is then like a traveller journeying on foot, who notes every feature of the road, and tries each side-path before the right one is found. He not only learns every inch of the country, but understands the nature of its inhabitants. He knows his way and can direct others. I can only look upon it, therefore, as a piece of good fortune that synthesis demands the creation of countless new methods of construction, separation, and recognition, and the study of hundreds of intermediate products before the proteids themselves can be reached. For these methods not only serve in the end to produce all the natural albumins, but bring to light many more which may eventually serve to explain the remarkable changes which certain proteids effect in the form of ferments and toxins.

J. B. C.

THE PROTECTION OF BIRDS.

IN its report for 1905, the Royal Society for the Protection of Birds directs attention to the circumstance that the year under review is the first during which it has enjoyed the privilege of a Royal Charter. Reference is also made to the importance of last year's ornithological congress in connection with the recognition of the great principle that bird-protection is an international affair, and that, in the case of migratory species, it is of little use to adopt protective measures in this country if indiscriminate slaughter is carried on abroad. It is, moreover, also pointed out that we are by no means free from reproach in this matter even at home, as is exemplified by the instance of a honey-buzzard which was killed and mounted in the Isle of Wight, although such procedure would have been illegal in Hampshire. The progress of bird-protection in India is referred to with approval; but it is stated that further international action is required in connection with the trade in "osprey-plumes."

Simultaneously with the report of the English Society for the Protection of Birds, we received those of the kindred American body, the National Association of Audubon Societies, for 1904 and 1905. The former of these contains a history of the "Audubon movement" in the United States by Mr. W. Datcher, the president of the association, and also the results of a special effort for the protection of water-birds, made possible by a fund at the disposal of the association. In the report for 1905 the president has to congratulate the association on its first year's working as a corporate organisation, the incorporation having largely augmented its power for good. After referring to the cordial relations existing between the association and foreign bodies the work of which is of a similar nature, the president directs special attention to correspondence relating to the urgent need of protection for the extensive bird-colonies in certain islands in the Pacific. Special efforts are being made to enlist the interest of the general public in bird-protection by means of exquisitely illustrated leaflets (of which we have received a sheaf) descriptive of some of the rare and more interesting birds. In the case of the cardinal and so-called American goldfinch, the illustrations are coloured.

THE PLACE OF POLYTECHNICS IN EDUCATION.[1]

THOSE of you who know what you are doing here and know what is being done in other places must feel that we are at a very interesting, almost a critical, time from an educational point of view. We may be said, indeed, to be at the beginning of a new renaissance—a new birth of learning, just in the same way that our forbears, A.D. 1000 up to A.D. 1200, were in the forefront of that first renaissance. But the trouble is that the dark ages did not cease then, for we have had a dark age since, and it is to correct this second dark age that this new birth is necessary. Now what did the inhabitants of Europe do at that first renaissance? They kept on the schools which had been brought down by the different rulers, the different church authorities, from the time of the Roman Empire. The Roman schools, judging from what the Romans did from Scotland to the south end of the Red Sea, must have dealt with the science of the time, and that perhaps is the reason that the earliest universities always included "the nature of things" in their curricula. A modern public schoolmaster might not think their education complete because Latin and Greek were the modern languages then, and the students were taught no dead ones; but, be this as it may, at the renaissance they insisted upon the teaching of Latin, because then everybody who was anybody spoke Latin—it was the *lingua franca* of Europe—and not to speak Latin was to belong to the corps of the deaf and dumb. Secondly, they had to learn Greek, because the movers in the educational world at that time were chiefly doctors, and they had learned all they could about doctoring and surgery from bad Latin translations of bad Arabic translations of the Greek authorities, so that when the Greek manuscripts became available all the world was agog to learn Greek in order chiefly that they might learn medicine and surgery. Now, I want to point out to you that in this we had education founded absolutely and completely upon the crying needs of the time. Very good. Then if we are going to do anything like that in our new renaissance, what ought we to do if we are to follow precedent? We must arrange our education in some way in relation to the crying needs of the time. The least little dip into the history of the old universities will prick the bubble of classical education as it is presented to us to-day. Latin was not learned because it had the most magnificent grammar of known languages. Greek was not learned in consequence of the transcendental sublimity of ancient Greek civilisation. Both these things were learned because people had to learn them to get their daily bread, either as theologians or doctors or lawyers, and while they learned them the "nature of things" was not forgotten.

Now what is the problem of to-day? We are in a world which has been entirely changed by the advent of modern science, modern nations, and modern industries, and it is therefore perfectly obvious that if we wish to do the best for our education it must be in some relation to those three great changes which have come on the world since the old days. Remember, in the old days there was no experimental philosophy, there was no steam, there was little relation practically between the ordinary lives of the people and the phenomena, or, at all events, the working of the world of nature around them. But with us all our life, the poorest life, the richest life, the country life, the town life, if it is to be lived properly and wholesomely, has to be lived in the full light of modern science; we have to know exactly the best thing to do and why we should do it. The problem before us to-day, if it be the same problem that was before those old peoples, the problem, that is to say, of learning everything we can from those around us in other nations, must drive us to the study of modern languages, just as the modern world conditions drive us to modern science, so that there, I think, we have an answer to those who may ask of us: What changes are you going to make in modern education if you are going to have the best possible education? First of all, we have the fact that we are bound, if we follow precedent, to deal with those things which are of importance from the present point of view. Latin is no longer the *lingua franca* of Europe, and we have better guides in science and philosophy than Aristotle. A question which arises when we go on to consider this matter is a very simple one: Is it worth while bothering about education? Is it worth while troubling to inquire what the old renaissance did or the new renaissance ought to do? Now there we approach a question in which the world is certainly very much wiser than it was a few years ago. Thirty or forty years ago, I am sorry to say, in this country practically nobody cared anything whatever about education, at all events about the education of the people, and the trouble with us now—the trouble that we shall have to take years to get over—is that in Germany that question was settled as early as the time of Luther, who insisted that it was the duty of all communities to look after the education of their children as well as the building of bridges and the making of roads. Now I think it is generally accepted, both in this country and in others, that whether the citizens of a State are educated or not is a matter of absolutely supreme importance, and when I say "educated" I mean educated morally and physically as well as intellectually. It is no longer merely the concern of the child or of the child's parent. It is acknowledged to be the only true foundation for a

[1] Extracts from an Address delivered at the Borough Polytechnic Institute on December 4, 1905, by Sir Norman Lockyer, K.C.B., F.R.S.

State's welfare and continued progress under conditions of peace or under conditions of war. We must face the applications of all the new sciences to every department of our much more complex national life, from the lowest employment to the highest fields of statecraft. If this is anything like true we have a great responsibility cast upon us when we talk about education. And when we inquire into the conditions we are still more impressed by this strenuous necessity of looking the facts in the face and seeing how this question affects us, not merely as being in this Borough Polytechnic, but as being Britons, as being members of a civilised community in the twentieth century. I have already said that even so far back as the time of Luther the Germans insisted that all their children should be educated; there should be no difference between the rich and the poor. What has grown out of that? The thing has gone on from strength to strength, until now in Germany, to deal with the Old World, we find a country with the greatest number of universities, with the greatest possible desire, from the Kaiser down to the peasant, to do everything for Germany that can be done by educating every child that is born in the country. What did democracy do when it had fair play in the United States of America? The first thing done was to apportion millions of acres for the future endowment of education. The acres did not mean much capitalised then, but they mean a great deal capitalised now; so that in the western States of America, where you get the purest voiced democracy that you can get, I think, on the surface of the planet, the children of the citizens, boys and girls, are educated from the age of six to the age of six-and-twenty without any call upon the parents or without any hesitation to carry as many as possible up to the very highest form of education. And when does the technical instruction come in there? The technical instruction is given only to those who have taken degrees in the university. Japan is following on the same lines. The educational system of Japan was started as near as may be at the same time that the new educational policy was begun here. The result of it has been that you have in Japan now a completely trained nation, trained to think, trained to do the best along any line that may turn up, and the difference between the existence of such a training and its opposite we have now in comparing the present condition of Japan with the present condition of China. Japan has become a world Power with whom we are proud to associate simply because the Japanese children have been taught to think and to do for thirty years. That is one of the most blessed things to think of, because it shows that if any nation, even the British nation, ultimately finds that it is backward, some thirty years, or perhaps even twenty years, spent in Japanese fashion may put everything right. But if that is so, then it is my duty to point out to you that we have a great deal to do. I have said that our present system of education was commenced, roughly, some thirty years ago, when the Japanese system was started, but at present our system deals only with primary and secondary education. It is a most extraordinary thing that our Minister of Education has not anything to do with the most important part of education. It is a situation truly British. Well, if we find that it is necessary to imitate the action of other States in having a department which shall include the top of education as well as the bottom, it is right that I should tell you at once that this will cost a great deal of money above what we spend at present. If we take one German university, Berlin—the equivalent of the University of London—the German State spends on it the sum of 169,000*l*. a year. That is to say, it spent that sum in the year 1891–2; whereas for our higher educational institutions—all the universities and university colleges in England, Ireland, Scotland, and Wales—until quite recently, the British Government allowed a smaller sum. That, I suppose, perhaps may be considered a fair estimate of the importance of education in the eyes of the British Government and in the eyes of the German Government. The worst of all this is that it is not merely a question of money and increasing taxation; it is a question of the hampering of all the industries of the country from top to bottom, from John O'Groat's to Land's End. In an official document published by the United States Government some four years ago, it was stated, as a result of considerable inquiry, that, taking the day students in the United States, in those colleges and universities where only day students were considered, there were more teachers of science in the United States than there were students of science turned out from the English colleges. Now, if that or anything like it is true, do you think that in any continued competition along any line in connection with any industry in the United States and here, we are likely to come out top? It is absolutely impossible. Sir William Mather, more recently, has given us some information on this point. He spent four months in America looking up the technical colleges and the conditions relating to the education of the industrial classes. He found that ten years ago there were attending educational establishments, that is to say, universities and colleges, 32,000 day students; all these were taking a three years' course. Today there are 65,000 students being educated at these same colleges, and he says the spirit of America is so completely aroused to the necessity of making science the basis of all industry, it does not matter whichever it is, however simple the undertaking, that the whole tendency and trend of thought and feeling is to educate large masses of their young men so that they may take their part, not only as managers, employers, and capitalists, but as foremen and chief workmen in their great industries; and he ends by saying that it is necessary that we should urge our Government, whether it be Liberal or Conservative, to take care that there should be sufficient expenditure provided to enable our young people throughout the length and breadth of the land to possess equal advantages to those of young people of Germany and America.

If it is right that there should be this education, conferring upon the nation these enormous advantages, in considering the thing from the point of view either of the child or the child's parent, should there be one State-aided education for the rich and another for the poor? That is to say, if education—the *best* education—is worth all that is claimed for it, should the State deliberately foster the artificial production of a breed of second-rates? How can every child have a fair chance? Some of the older ones among you may remember Kingsley's "Saint's Tragedy." I will just quote two verses, with a little alteration in one:—

"The same piece of clay makes a tile,
A pitcher, a taw, or a brick;
Dan Horace knew life—you may cut out a saint
Or a bench from the self-same stick.

"We fall on our legs in this world,
Blind kittens tossed in neck and heels;
'Tis education that licks Nature's cubs into shape,
She's the mill-head if we are the wheels."

Surely, then, if we must not differentiate education, if we must not knowingly support second-rate education, our duty is to find the best. We come, then, to the problem which I have not the courage to bring before you now, because one might talk for a week about it, and I have only twenty minutes left, even if you will grant me as much as that.

What is the best education? It has taken the world a long time to find out what it already knows about it, but I doubt whether even now the world has quite got to the bottom of the problem. I think we may begin by saying that the best education should teach us to learn how to think, how to observe and how to use our hands, eyes and brain; how to exercise the body, how to become good and useful citizens, and—this is my own notion, perhaps you all will not agree with it—how to bear arms. If you have such an education as that going on all over the United Kingdom, my idea is that, whatever may happen to them afterwards, whether the children become archbishops or ploughmen, they would not be harmed by such an education, and, as a matter of fact, they could not have spent their time better. Now that is a very important thing to bear in mind, because there are systems of so-called education about which it could be shown in a moment that those who have been put under them might have spent their time very much better. We must discriminate really very much more carefully than is generally done between education, which I will define as the power of learning how to think, and instruction, which means the accumulation of facts. Education may bring us into contact with doing things by which money may be earned, but that contact in education is used for mental training. Useful knowledge may easily become the bane of education. Instruction in doing things frankly pursued for the purpose of earning a living is generally not so imparted that the power of thinking properly is increased and the general training carried on further. If that is anything like true, we come to the important consideration that the best teaching must certainly include the teaching of doing things—we must not merely cultivate the memory—and, above all, we must not stuff useful knowledge or anything else into those young minds with which we have to deal. They are not Strassburg geese; and the more you attempt to stuff them the worse it will be. What we have to do is to train the mind as a delicate rapier, enabling it to do anything it has to do in the most perfect manner—to train the eye, the hands, the brain to face anything under the best possible conditions. The question here arises, What sort of a Code have we now for the education of the young?—this new Code—the Code for the year 1905 for elementary schools. Well, for myself, I thank God that we have such a document. It is an enormous improvement upon everything, upon anything, which has gone before it in our country. I remember some twenty years ago, when the only concession made to the new knowledge was that some candidate, if he liked, might say something of what he knew about the common pump; it hardly went further than the common pump, but the new Code goes very much further than the common pump, and you may even look at the stars if you like; you may even observe once or twice a year where the sun is or where the moon rises. Having this official education for the young, how are we to deal with it in relation to such an institution as yours? How are we to consider what should happen to the young minds of boys and girls going up that educational ladder which Huxley pictured to us some years ago—that educational ladder from the gutter to the university? In considering such a ladder as this, of course the end of the teaching, the end of the time spent, in the primary school constitutes the first rung at which the educational ladder may be left, and you have to consider the certain number of boys and girls unfortunately getting off the educational ladder when they leave the elementary school. The question arises, Must everybody when they leave the primary school, and that, I am thankful to say, at a gradually increasing age; when they have done with the official, with the complete education, must they have done with the instruction which will enable them better to earn their daily bread—the instruction which should, if possible, be placed before them, because really it is to tackle that instruction and to tackle the life connected with it that they have been taught to think? If you omit to give a higher education, or education combined with instruction, to your boys and girls after you have taught them to think, you have made a good deal of that education ridiculous. Your institute proves that it is much better to give instruction to the young in things that they have to do before you make them absolutely face the music in the real contact with the stern world of reality, which they will certainly have to face sooner or later. When you consider, therefore, the stepping-off places from the education ladder—I have just referred to the first—and the necessity of getting instruction, of putting instruction in the way of those who have to step off the educational ladder, the importance, the enormous importance, of such an institution as yours begins to force itself upon one. Take the child in an elementary school under the present regulations. Instead of going on to the secondary school and continuing still further up the educational ladder, it can go to a higher elementary school. That is a new idea in England, and it is a very admirable one. When you ask, Why does the child step off? you will find yourself confronted chiefly with the dearness of education in this country, and then with the supposed necessity for early employment.

With regard to those two questions, I would just like to tell you a little story. I had, some thirty years ago, to visit Holland on an official mission, and among others I saw the Minister of Public Instruction there, who was a great friend of Prof. Reike, to whom I was accredited, and he told me what they had been doing then in Holland for the last six or seven years; precisely this same thing that the Board of Education is now doing with regard to the higher elementary schools. The boys left the elementary schools generally at the age of fourteen, and the habit was for those little creatures to be sent at once to the offices and counting-houses of the merchants in Rotterdam and Amsterdam and other places to begin their work as clerks, and the Minister told me, with a twinkle in his eye, that these shops and counting-houses were most extraordinary places, because they were full of high stools. The Minister thought he could not proceed with this suggested change of the continuation school, which was called the higher town school, until he could get the sympathy of those various merchants, and he went round and asked them whether, if he could prepare boys up to the age of seventeen years, they would make a trial of them. They said they would. I visited Holland some four or five years after this had taken place, and the Minister told me that if I went to Rotterdam or Amsterdam I should no longer find any of those tall stools. He said:—"Seventeen-year-old boys are there, and they will have none others; the time for the use of the boy of fourteen in a merchant's office in Holland has passed away; the boys who begin to do their work after they have been taught to think up to seventeen are so much better." There is just another story touching another point I will say a word about later. The Minister was so interested with this, and was so satisfied and delighted at the satisfaction which those boys gave to their employers, that he thought he would go a step further. I should tell you that the boys who continued in school after fourteen up to the age of seventeen were chiefly taught science and Latin, and he was anxious to know what would happen in the case of a competition between these boys and those from the gymnasia, which are the equivalents of our higher grammar or public schools in this country. The boys from the gymnasia went, in the natural course, when they left the gymnasia, to the university. So he obtained permission from the Government to give the high town school boys an extra year. Now, what did they have to do in this extra year? They had learned Latin, and they had learned science from the age of fourteen in their continuation school; all they had to do was to learn Greek. It seemed an impossible thing for the town schoolboys to attempt to learn as much Greek in nine months, which was the school year, as the boys in the gymnasia, who had been accumulating during nine years their instruction in the gymnasia and the primary schools; but, as a matter of fact, when the test leaving examination came to be gone through, the boys from the higher town school romped in over the gymnasia boys. So you see my story shows that the university is not an absolutely prohibited thing if those who have to do with the boys and girls concerned are keen enough to take every advantage of every opportunity; and it shows also that employers of labour, at all events in other countries, and I expect in this, will see the advantage of getting supplied with clerks and other assistants who have been taught to think as opposed to getting their offices crowded with people who have still to learn how to think.

There are several other questions connected with the Huxley educational ladder. One is that in leaving each rung we have frankly to acknowledge that we have to face the music of the struggle for existence. Not every boy who enters a primary school can go, of course, to the university, can go perhaps higher than a secondary school; some will even fail to get to a secondary school, but what you have to consider, I think, generally in relation to institutions like this is that if there is to be any stepping off the ladder the change must be made in the best possible way. The present system of allowing these changes from rung to rung to take place by examination by outsiders is, I think, absolutely and completely indefensible. I would hold the teachers in every primary school absolutely responsible for saying that such and such of their students will benefit by secondary education and some of their students will not, and if that be done, then, in consequence of the recent action of the London County Council, it seems to me that you will have a rapidly increasing number of the best English boys and girls going on with their pure education, certainly well into the secondary stage. In this way you will catch your potential Faradays. One of the delightful things I found in my inspection here with Mr. Millis was that in your instruction, frankly so called, you make it as educational as you can, so that those who come to you after the age of the primary school may, if they so choose, by taking advantage of one or other of your organisations, not only get an immense amount of absolutely needed instruction for various walks of life, but an education which will be practically as good as an education which could be got on the ordinary education ladder to enable them to enter the universities. The recent improvements in education are brought home to us by the fact that Huxley's ladder by itself no longer represents all the present possibilities. There are now platforms at the chief stepping-off places, and ladders from them also leading to the university for those who do not fear to climb. These platforms are technical schools and institutes, in which practical training in science laboratories and literature must both find place.

There is one word I should like to say with regard to your day school. It is called a "Technical Day School for Boys." I find that in the London County Council list, Appendix B, it is called a "secondary school." Now are you a secondary school? That is a point that I am not quite familiar with. What I understand is that under the new regulations a school to be a secondary school must make application to the Board of Education to be reckoned as such, and if it is accepted you have this enormous advantage, or will have very shortly, if you have not it now. Your students will have the right to go to the university by passing the leaving examination, which will ultimately be carried on by the teachers in the secondary school, or, at all events, with teachers associated with the secondary school. I think you will agree with me that the less any education in any locality is fettered by examination by outsiders the better for that education it will be. If you are a secondary school your students will be able, as a matter of course, to enter the new university. Thank God that in London, after centuries of the neglect of education, we have a university; we shall soon be as well off as a good many second-rate towns on the other side of the water have been for hundreds of years. I believe it is settled that your students can matriculate at the university, can become internal students without the bugbear of Latin, if you look upon Latin as a bugbear. Personally, I do not; if you have time to learn Latin, so much the better, but if the struggle for existence is so great that it is science or nothing with you, well, with science you can now enter the London University from a secondary school. You will then carry your local students right up to the second rung, some will go on to the university, and some will step off to your evening classes. Voltaire, talking about education, said:—"On étudie les livres en attendant qu'on étudie les hommes" ("We study books before we have a chance of studying men"). Well, we have got past that now; we not only study books, but we study things, but whether we study books or things our education will not be complete until we study men, that is to say, until we have varied occasions of mingling with others who are thinking about other things, so that we may exchange thoughts and ideas and sympathies with other students of different branches of knowledge. Now I want to point out what a magnificent opportunity you have here for that kind of collegiate education. You are practically a college, and I believe strongly that this collegiate life, as we may call it, this mixing with one's fellow men, is of the very highest quality, that it is the absolute essential of a complete course of education which should produce what is called character. And let me remind you that people are prepared to pay a great deal for character. I find, for instance, that Mr. Balfour not very long ago said the collective effect of our public school education on character could not be over-rated, but he thought the boys of seventeen or eighteen who are educated in them do not care a farthing about the world they live in except so far as it concerned the cricket field, the football field, or the river. You have the machinery to enable you to care a great deal about the world you live in, to know an immense deal about it, and you have also the machinery for this formation of character. Now I believe in the combination, and it is upon that ground I hope some future day to see a strong secondary school here. I believe it will be a very great boon to this part of London; in fact, I feel so strongly on this that I should say your enormous advantages would be wasted if you did not take some part in the general scheme of pure education, and that part is quite obvious; you have to make your day school one of the best secondary schools it is possible to imagine. I should have hesitated to give you my opinion on your proper place in education and the excellence of your teaching staff and laboratories if I had not had an opportunity of examining your institution, and, in concluding, I want again to thank Mr. Millis for his very great kindness in showing me over it the other day.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. S. LULL, associate professor of zoology at the Massachusetts Agricultural College, has been appointed assistant professor of vertebrate palæontology in Yale University, and associate curator of vertebrate palæontology in the Yale University (Peabody) Museum.

PROF. W. W. WATTS, F.R.S., who is leaving Birmingham to take up the professorship of geology at the Royal College of Science, was entertained by his geological friends in Birmingham on March 23. Prof. Charles Lapworth, F.R.S., who presided, referred to the many services which Prof. Watts had rendered to geological students. Prof. Watts, after acknowledging the presentation made by Mr. J. Whitehouse on behalf of the past and present students, said that he was going to a school which would be in healthy but friendly rivalry to the Birmingham school.

AMERICAN institutions for providing higher education continue to benefit from the generosity of wealthy American citizens. *Science* announces that Princeton University has been made the residuary legatee of the estate of Mrs. J. Thompson Swan, which is said to be worth about 60,000*l*. The late Mr. Edwin Gilbert, of Georgetown, Conn., has left 12,000*l*. for the model farm of the Connecticut Agricultural College. Harvard University has received a gift of 10,000*l*. from Mr. R. W. Sayles, of Norwich, Conn., to establish a fund, preferably for the acquisition, preparation, and maintenance of collections suitable for a geological museum.

THE Board of Education has issued a return showing the extent to which, and the manner in which, local authorities in England and Wales have applied funds to the purposes of technical education, and other forms of education other than elementary, during the year 1903–4. In consequence of the fact that the Education Act, 1902, was coming into operation throughout the year with which the report deals, and that advantage was taken of this fact to initiate a new series of returns of this form of expenditure, the year must be regarded from the statistical point of view as transitional in character. The volume is, in fact, divided into two parts, the first continuing for about half the total number of local authorities the former series of returns, and the second initiating the new series for the remainder. The consequence is that the volume provides no total of the figures dealing with the whole country, and in view of the incompatibility of the bases of the expenditure shown in the two parts, such totals would only be misleading.

THE 1906 issue of the "Register and Official Announcement" of the Clark University, Worcester, Massachusetts, has been received. Among other interesting information, it may be noticed that the University has several funds for the endowment of fellowships. A sum of 600*l*. is now available for junior and senior fellowships from the George F. Hoar fund of 20,000*l*., provided by the generosity of Mr. Carnegie. There are in addition a citizen's fund of 1000*l*., the income of which is to be used for the aid of "some one or more worthy native-born citizens of the city of Worcester who may desire to avail themselves of the advantages of the institution," and the Field fund of 100*l.*, the income of which is "to provide for the minor needs of a scholar or fellow." These fellowships are intended for young men and women of promise who desire to pursue post-graduate studies in order to fit themselves for intellectual careers. In general, those intending to devote themselves to some special branch of learning are preferred to those directly fitting themselves for one of the "three learned professions."

AT the Convocation of the Calcutta University on March 3, the Vice-Chancellor, Sir Alexander Pedler, dealt with the work of the University during the period 1873–1905. He said that the number of schools sending up candidates to the matriculation examination of the University was three times greater at the end than at the beginning of the period. In the same interval the number of colleges in connection with the University increased from fifty-two to eighty-one, and the number of professors and lecturers in these colleges from 278 to 717. Sir Alexander Pedler went on to ask, Has the University in any way troubled itself to secure that this expansion has been accompanied by the provision of three or four times the number of equally well trained and experienced professors and teachers? Has the University ascertained that the new schools and colleges are equal in quality to those of older and more mature growth? Are three or four times as many well trained or well paid teachers at work in the colleges and schools as thirty years ago? Are there three times as many professors or teachers for the colleges, trained in all the modern developments of western learning and acquainted with all the most recent discoveries in science as there were thirty years ago? To all these questions he said a direct negative must be given. The Government, which in its colleges ought to take the lead in such matters, has allowed a reverse policy to go on, and while in 1873 in Bengal the number of European professors or Indian professors with European training in Government colleges was thirty-one, in 1905 the number had fallen to twenty-seven, while the number of Indian or Indian trained professors had increased from nineteen to sixty. In university work in European countries and in England, when the number of students under instruction in colleges is compared with the number of professors and lecturers in various subjects engaged in teaching them, it is found, Sir Alexander Pedler said, to be about ten students to each professor. In the case of American technical colleges, frequently the ratio works out at one professor to seven or eight students. At the Michigan University one professor for every six students is found, and also at the Toronto University. Turning to the case of India, in the arts sections of certain colleges affiliated to the Calcutta University, for every professor there are such numbers of students as fifty-three or forty-six, and other similar numbers, or from five to nine times as many students as in other countries.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 18.—"A Study of the Mechanism of Carbon Assimilation in Green Plants." By Francis L. **Usher** and J. H. **Priestley.** Communicated by Prof. W. M. Travers, F.R.S.

(1) The photolysis of carbon dioxide may take place outside the plant in absence of chlorophyll, provided one of the products is removed.

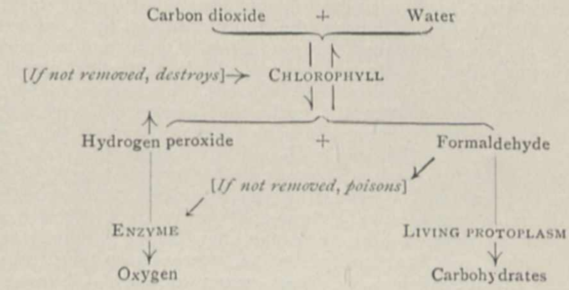
(2) The normal products of the photolysis are hydrogen peroxide and formaldehyde, though under certain conditions formic acid may be formed.

(3) In the plant the decomposition of the hydrogen peroxide is provided for by a catalysing enzyme of general occurrence.

(4) The condensation of the formaldehyde is dependent on the healthy condition of the protoplasm.

There are therefore three factors essential to photosynthesis from carbon dioxide and water in the plant; they are (1) vitality of the protoplasm, (2) presence of a catalysing enzyme, and (3) presence of chlorophyll. If any one of these factors be interfered with, the process of photosynthesis ultimately comes to an end, through the destruction of the optical sensitiser, chlorophyll.

The relations between the various factors in this process may be diagrammatically expressed thus:—



Society of Chemical Industry, March 5.—Mr. A. G. Salamon in the chair.—The ignition of nitro-compound explosives in small arm cartridges: W. D. **Borland.** The action of the igniter, *i.e.* the percussion cap, is to eject through the fire holes of the case a mixture of solid and gaseous products at temperatures between 2400° C. and 3200° C. in such quantity, volume, and time that the initial resistance of the bullet or shot is overcome before the bulk of the charge of powder develops its full energy, but without any hesitation which may upset alignment or perceptible "hang-fire." The rapidity with which these gaseous and solid matters are applied to the powder is determined by exploding the percussion cap in a hollow steel cylinder provided with a hardened steel plunger and resting upon a crusher lead. The proportion which the crushing pressure bears to total energy is found in practice to be a trustworthy guide to the rapidity with which the heat of the igniter is applied to the explosive, and consequently to the ratio which chamber pressures in the small arm bear to observed velocity of projectile. The volume of the gaseous matters in relation to the surface of the explosive can be readily determined. These must be large enough to ensure sufficiently high chamber pressures being set up for the most efficient combustion of the powder. The temperature of ignition was determined by radiation methods of observation, the cap being exploded into a glass tube and the radiation intensity of the solids observed by comparison with a radiant of known intensity, the portion of the spectrum chosen being in the neighbourhood of 6563 wave-length. The paper includes tables illustrating the action of different igniters on different explosives, both sporting and military, and tracing the effect of total heat energy and temperature of igniter upon velocity, pressure, and rapidity of ignition observed in ballistic trials.

Zoological Society, March 6.—Mr. C S. Tomes, F.R.S., vice-president, in the chair.—A specimen of *Rana goliath*, obtained by Mr. G. L. Bates at Efulen, in South Cameroon: G. A. **Boulenger.** This frog measured 10 inches from snout to vent, and was much larger than any frog hitherto known.—"Flying" snakes: R. **Shelford.** The power of "flying" has been recorded by natives to be possessed by three species of snakes in Borneo, viz. *Chrysopelea ornata*, *C. chrysochlora* (Opisthoglypha), and *Dendrophis pictus* (Aglypha). All three species have the ventral scales with a suture or hinge-line on each side; by means of a muscular contraction these scales can be drawn inwards, so that the whole ventral surface of the snake becomes quite concave, and the snake itself may be compared to a rod of bamboo bisected longitudinally. By experiments on *C. ornata* it was seen that the snake when falling from a height descended, not in writhing coils, but with the body held stiff and rigid, and that the line of the fall was at an angle to a straight line from the point of departure to the ground. It is highly probable that the concave ventral surface of the snake helps to buoy it up in its fall; it can readily be shown that a longitudinally bisected rod of bamboo falls more slowly than an undivided rod of equal weight.—A series of reports on the zoological results of the third Tanganyika expedition conducted by Mr. W. A. Cunnington in 1904–5 was read. Report on the fishes: G. A. **Boulenger.** The collection consisted of 300 specimens referable to eighty-four species, twenty-eight of which were new.—Crustacea: Dr. W. T. **Calman.** In addition to the two species already known from Lake Tanganyika, no fewer than ten specimens of new species belonging to the family Atyidæ, including the representatives of two new genera, were obtained. From lakes Nyasa and Victoria Nyanza only a single species was obtained, the widely distributed *Caridina nilotica* (*C. wyckii*). The absence of this common species from the gatherings made in Tanganyika emphasised the isolated character of the Macruran fauna of that lake. All the species found in Tanganyika, and all but one of the genera, were peculiar to the lake. There was no ground for regarding the Macrura of Tanganyika as having any specially "marine" affinities. The other members of the groups to which they belonged, the genus Palæmon and the family Atyidæ, were characteristically, and all but exclusively, fresh-water animals.—Mollusca: E. A. **Smith.** This collection contained examples of thirty-three species, one of which was new.—Fresh-water sponges obtained from lakes Victoria Nyanza, Tanganyika, and Nyasa: R. **Kirkpatrick.** The collection comprised eleven specimens representing five species, one from Tanganyika being new to science, two others from Tanganyika (*Spongilla moorei*, Evans, and *S. tanganyikae*, Evans) having already been recorded from that locality. Small specimens of a fourth species, viz. *Spongilla carteri*, Bowerbank, were obtained from the Victoria Nyanza, and a fairly large specimen of a fifth, viz. *Spongilla biseriata*, Weltner, was collected in a swamp bordering Lake Nyasa. Included in Mr. Kirkpatrick's report were descriptions of two new species and a new variety of fresh-water sponges, based on material obtained from the White Nile.—Oligochæte worms: F. E. **Beddard.** They comprised examples of four new species.—The medusæ of the genus Limnocnida obtained during the expedition: R. T. **Günther.**

Geological Society, March 7.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The occurrence of limestone of the Lower Carboniferous series in the Cannock-Chase portion of the South Staffordshire Coalfield: G. M. **Cockin.** Silurian limestone underlies the Coal-measures in the southern part of the South Staffordshire Coalfield, and a rock, probably similar, was found in a borehole at Cannock-Chase Colliery. A shaft was sunk some thirty years ago north of the latter locality, but was abandoned. In the waste-heaps, which have remained undisturbed since 1875, a number of fossils belonging to the Lower Carboniferous Limestone have been found. A fault must be presumed to bring Carboniferous Limestone into the position indicated. An account of the strata pierced by boring is appended.—Liassic Dentaliidæ: L. **Richardson.** Among the fossils collected in the cuttings on the new Honeybourne and Cheltenham Railway were many belonging to the family Dentaliidæ, and, as the majority are new, the author has investigated the Liassic members of the family contained in several collections. The growth of the scaphopod-shell is effected by additions at the anterior end, while the posterior end suffers by wear and absorption. The members of this class are essentially marine, inhabiting deep water, and feeding principally on Foraminifera. Eight new species are described, and eight species already known are discussed.

Entomological Society, March 7.—Mr. F. Merrifield, president, in the chair.—Two specimens of *Microdon latifrons*, Lw., a rare dipteron taken in the New Forest in June, 1905: H. W. **Andrews.**—Examples of *Nonagria neurica*, Hb., and *N. dissoluta*, var. *arundineta*, Schmidt, from Germany, with (?) var. *arundineta* from Central Asia, for comparison with *N. dissoluta* and *N.* var. *arundineta* from Kent, Cambridge, and Norfolk: H. M. **Edelsten.**—A variable series of *Gynopteryx gladiaria*, Guen., and its varieties: L. B. **Prout.**—Combs of the honey bee formed on a branch of nut tree, the bees having swarmed late in the year: A. J. **Chitty.** After July the bees deserted the combs, and, having consumed all the honey contained in them, again swarmed on a neighbouring tree.—A specimen of *Prodenia littoralis*, Boisd., which had emerged in a breeding-cage kept, with many others, by Major R. B. Robertson at Boscombe, Hants, for the reception of caterpillars found in that district: Prof. R. **Meldola.** The moth emerged on July 16, 1905. The species, which is figured in Hampson's "Moths of India," is said to have a distribution extending from the Mediterranean subregion throughout the tropical and subtropical zones of the Old World.—A Mantis on a portion of the bark of a tree found by Mr. F. Birch in Trinidad, who stated that its close resemblance to a withered leaf was evidently a protection for aggressive purposes: O. E. **Janson.**—A series of Callimenidæ; a small family of Orthoptera, consisting of two genera, Dinarchus, with the single species *D. dasypus*, Illig., and Callimenus, of which all the known species were included, with the exception of *C. inflatus*, Br., from Asia Minor: M. **Burr.**—Specimens of *Argynnis niobe*, var. *eris*, ♀, from the Pyrenees, Cevennes, and south Tyrolese mountains: H. **Rowland-Brown.** Attention was directed to the remarkable form of the example taken at Gavarnie, in July, 1905, of which the coloration of the upper side of all the wings was ruddy copper-red shot with blue upon the nervures. Whereas specimens of *eris* and other Argynnids from the mountainous regions of central France showed a tendency to maintain constant pale forms, those from the Pyrenees are generally more highly coloured, while the high Alpine forms of Central Europe inclined to melanism.—An original note-book of Burchell's taken to South Africa in 1812: Prof. E. B. **Poulton.** The note-book established the date of the author's birthday, hitherto unknown, to be July 12, while it also recorded, for the first time, the superstitious dread of the native Hottentots for the "death's head moth," known locally as the "devil bee."—Specimens of Pierine butterflies from South Africa, India, and Asia Minor: Dr. F. A. **Dixey.** The specimens illustrated how the under sides of the dry-season forms in the group are apt to take a red tinge, and it was especially interesting to note that the same tendency was manifest in all species collected from such widely separate regions.—Note on the migration of Lepidoptera against the wind, extracted from a report on "The Pearl Oyster of the Gulf of Manaar, *Avicula (meleagrina) fucata*," by Henry Sullivan Thomas, in the *Madras Journal of Literature and Science*: C. O. **Waterhouse.**—A plague of ants in the Observatory district, Cape Town, South Africa: Colonel C. T. **Bingham.**—Some rest attitudes in butterflies: Dr. G. B. **Longstaff.** The paper was illustrated by numerous specimens arranged upon backgrounds of specially prepared sand-paper approximating to the natural surroundings of the insects in their various habitats.—Observations on the life-history of *Trichoptilus paludum*, Zell.: Dr. T. A. **Chapman.**—Some parasitic hymenopterous insects of North Queensland: F. P. **Dodd.**

Physical Society, March 9.—Dr. C. Chree, vice-president, in the chair.—The velocities of the ions of alkali salt vapours at high temperatures: Prof. H. A. **Wilson.** This paper contains a summary of previous work. It is shown that all results so far obtained are consistent with the view that any salt of cæsium, rubidium, potassium, sodium, or lithium gives in a Bunsen flame negative ions having a velocity of 1000 cm. per sec. for one volt per cm., and positive ions having a velocity of about 80 cm. per sec. This result can be explained by supposing that each salt molecule emits a negative corpuscle which forms the negative ion, and that the rest of the molecule forms the positive ion.—Some experiments on earth-currents at Kew Observatory: Dr. J. A. **Harker.** An account of experiments made some years ago at Kew Observatory on the earth-currents produced by electric traction schemes, and on the disturbances they cause on the self-recording magnetic instruments kept continuously running to register the variations in the declination and the horizontal and vertical forces. Two large earth-plates were buried about 4 feet deep and 200 yards apart, and connected through a photographic recording voltmeter of high resistance. On the traces given, the effect of the trains on the Central London Railway was strikingly shown. The nearest point to Kew is about six miles distant. The same disturbances, and also those due to special traction experiments carried out on the system of the London United Electric Tramway

Company during the period when the Central London Railway was shut down, were also clearly shown on magnetograph curves. The effects are much greater on the vertical force than on the horizontal force or the declination. A second system of investigation was to connect the earth-plates through the primary of a transformer, the secondary terminals of which were connected to a sensitive moving-coil galvanometer of suitable period and damping. The galvanometer recorded a ballastic throw for each movement of a tramway controller, while the slower variations due to magnetic storms were without effect. A telephone similarly connected gave a perceptible sound for each controller movement.

Royal Meteorological Society, March 21.—Mr. R. Bentley, president, in the chair.—South Africa as seen by a meteorologist: Dr. H. R. **Mill.** The lecture was illustrated by a series of lantern-slides from photographs taken during the tour of the British Association in 1905. The places visited included Cape Town, Table Mountain, Durban, Maritzburg, Ladysmith, Johannesburg, Pretoria, Bloemfontein, Kimberley, Bulawayo, the Matoppo Hills, the Victoria Falls of the Zambesi, Salisbury, Umtali, and Beira. During the return journey, Mombasa, Cairo, and the Suez Canal were visited. Photographs were shown of meteorological stations in many of the places named, and the views of the scenery were selected to bring out the climatic features.

CAMBRIDGE.

Philosophical Society, February 12.—Mr. F. Darwin in the chair.—Notes on cycads: with exhibition of a rare species acquired by the Botanic Garden: A. C. **Seward.** The author exhibited a plant of *Cycas Micholitzii*, Dyer, recently obtained by the curator of the Botanic Garden from Messrs. Sanders and Sons. This species was discovered by one of Messrs. Sanders' collectors, Mr. W. Micholitz, in Annam, and described last year by Sir William Thiselton-Dyer in the *Gardeners' Chronicle*, August 19, 1905, p. 142. The author directed attention to the importance of cycads as representing scattered survivals from a remote past, and as plants which still retain traces of ancestral characters.—Respiration and vitality: F. F. **Blackman.**—Experiments on the hybridisation of barleys: R. H. **Biffen.** The behaviour of the more important differentiating characters to be found among the varieties of barley has been investigated.—A comparison of the results from the Falmouth declination and horizontal force magnetographs on quiet days in years of sun-spot maximum and minimum: Dr. **Chree.**

February 26.—Dr. Fenton, vice-president, in the chair.—An indicator for strong acids and bases: Dr. **Fenton.** Reference was made in previous communications by the author to a new condensation product, derived from methylfurfural, which has the molecular formula $C_{11}H_8O_4$. It was pointed out that this substance may have useful applications in organic analysis, since it gives highly characteristic colour-reactions with certain classes of compounds, such as amines and ureas. In the present paper it is shown that the reagent serves also as an indicator of alkalinity, and further, that by condensation with urea a colourless base is obtained which is turned blue with acids, and may therefore be used as an acid indicator.—The action of acid chlorides of acetylenic acids on ketonic compounds: S. **Ruhemann.** The paper gives an account of experiments undertaken with the view of supporting the constitution of the product of the reaction between phenylpropiolyl chloride and acetylacetone, and the formula of the substance formed from it under the influence of secondary bases. The properties of this substance have been found to resemble in every respect those of oxalyldibenzylketone.—The dihydrotetrazines: S. **Ruhemann.** The author has extended his research on tetrazoline, and found that the properties of dimethyltetrazoline differ most markedly from those of tetrazoline.—The velocity of transformation of sugars by alkalies: R. S. **Morrell** and A. E. **Bellars.** Aqueous solutions of glucosates, fructosates, and mannosates of guanidine, potash, and soda undergo slow change indicated by a decline in the rotatory power. The velocity of change, as measured by the diminution of the optical activity of the solutions, is that of a unimolecular reversible reaction. Under the conditions of the experiments glucose and fructose are mutually transformable, the production of mannose and acids proceeding at such a slow rate that glucose and fructose first attain an equilibrium, which is afterwards disturbed by the appearance of steadily increasing quantities of saccharinic acid. In the case of guanidine mannosate solutions, the velocity constant obtained from observations of the fall in rotatory power has nearly the same value as the corresponding one for guanidine glucosate and fructosate, but direct measurement of the rate of disappearance of the mannose gave a very much lower value.—The influence of very strong electromagnetic fields on the spark spectra of (*a*) vanadium, (*b*) platinum and iridium: J. E. **Purvis.** The field strength was 39·980 C.G.S. units. (1) With regard to vanadium, two lines become sextuplets and four lines become quintuplets. There are a number of lines divided into four, whilst the great majority of them become triplets. Also there are a few doublets, and there are about eight lines which do not appear to be affected. The distances of the separated constituents from the normal lines were measured, and the value of $d\lambda/\lambda^2$ calculated; and it is seen that many of the lines may be expressed by the same formula, the appearances of the undivided lines and the separated constituents and the values of $d\lambda/\lambda^2$ being essentially identical. (2) Similarly, with regard to the metals Pt and Ir, there are lines of both metals which may be grouped together as possessing identical $d\lambda/\lambda^2$ values, and the normal lines and separated constituents of which are similar in appearance. (3) In several instances the values of $d\lambda/\lambda^2$ for the several constituents seem to be simple multiples of each other.

PARIS.

Academy of Sciences, March 19.—M. H. Poincaré in the chair.—Observations of nebulæ: M. **Bigourdan.**—The distillation of titanium and the temperature of the sun: Henri **Moissan.** The boiling point of titanium is very high, and it was necessary to employ a current of 1000 amperes at 55 volts in the electric furnace to volatilise it readily. The distilled titanium was obtained on the cold tube mixed with lime, distilled from the furnace body. This lime was removed by acetic acid, and the residue was proved by its chemical properties to be titanium. Taking the temperature of the electric arc as 3500° C. (Violle), it is clear from the fact that titanium vapour exists in the sun that the temperature of the sun must be above 3000° C.—Benzyl- and phenylborneols and their products of dehydration: the benzyl- and phenyl-camphenes: A. **Haller** and E. **Bauer.** The secondary benzylborneol was prepared by the reduction of benzylcamphor, and its dehydration by phthalic anhydride; formic acid and pyruvic acid gave rise to the α-benzylcamphene. The tertiary benzylborneol was prepared by Grignard's reaction from camphor; its dehydration gave an isomeric β-benzylcamphene, the properties and derivatives of which are described.—The facies of variation of certain nepheline syenites from the Los Islands: A. **Lacroix.**—Gennadas, or bathypelagic Peneids: E. L. **Bouvier.**—The sheet of the Geological Survey, on the scale of 1 : 80,000, dealing with the region of Gap: Michel **Lévy.**—Functions which depend on other functions: Vito **Volterra.**—Observations of the Kopff comet (1906*b*) made with the bent equatorial of the Observatory of Lyons: J. **Guillaume.** The observations were made on March 5, 6, and 7. The comet appeared as a nebulous star of 15″ diameter and about 10·5 magnitude.—Observations of the comet 1906*b* made at the Observatory of Algiers with the 31·8 equatorial: MM. **Sy** and **Villatte.** Observations were made on March 5, 6, 7, and 8.—A new solution of the problem of magnetic induction for an isotropic sphere: Tommaso **Boggio.**—The resistance of emission of an antenna: C. **Tissot.** A discussion of the most favourable conditions for using a thermal indicator as a receiver of Hertzian waves.—The mechanism of the positive light: P. **Villard.** The positive column in a Geissler tube is regarded as a chain of gaseous particles traversed by the current. It still remains to be determined whether the emission of light is due to the passage of the current or to the progressive dislocation of the chain by the shock of the negative ions.—Antimony and sulphide of antimony: MM. **Chrétien** and **Guinchant.**—The action of the amino-ethers and imino-chlorides on organo-magnesium derivatives: R. **Marquis.** An attempt at a new general method for the synthesis of ketones, starting with the imino-ether R.C(OR):(NR). The yield in the case of benzophenone is good, but the method is not general. In some cases the imino-chloride gives better results.—The preparation of glycidic ethers and of aldehydes in the hexahydroaromatic series: Georges **Darzens** and P. **Lefébure.** The glycidic esters were obtained by the interaction of chloracetic ester with cyclohexanone in the presence of sodium ethylate. The aldehyde is prepared from the glycidic ester by heating in a vacuum. The reaction has been applied successfully to homologues of cyclohexanone.—The structure and probable origin of the magnetic iron ore of Diélette, Manche: L. **Cayeux.** Conclusions as to the mode of formation of the ore are drawn from a micrographic study.—The gasteropods collected by the Charcot Antarctic Expedition: A. **Vayssière.**—The structure of the sporal wall of the Myxosporidia: L. **Léger** and E. **Hesse.**—A genus of lamellibranchs with multiple mouths: Paul **Pelseneer.** The genus Lima is characterised in its normal condition by having two symmetrical buccal orifices, each of which leads directly into the œsophagus.—X-rays and genital activity: F. **Villemin.**—The disease of wine (Graisse): E. **Kayser** and E. **Manceau.**—The toxin and antitoxin of cholera: MM. **Brau** and **Denier.** The serum of animals which have received the toxin under the skin possesses very slight antitoxic power. The antitoxic power of the serum becomes much more marked when the toxin has been injected into the veins.—The laws of muscular elasticity and their application to energetics: Charles **Henry.**—Some new palæontological data on the Devonian of western Ahenet, Central Sahara (expedition of MM. R. Chudeau and E. F. Gautier): Émile **Haug.**—The fauna of the Lower Coal-measures of Baudour (Hainaut): J. **Cornet.**—The flora of the same: Armand **Renier.**—Chalk and clay on the sea floor: J. **Thoulet.**

DIARY OF SOCIETIES.

THURSDAY, March 29.

Royal Society, at 4.30.—On the Dilatational Stability of the Earth: Lord Rayleigh, O.M., P.R.S.—On the Observations of Stars made in some British Stone Circles. Second Note: Sir J. Norman Lockyer, K.C.B., F.R.S.—The Calculation of Ellipsoidal Harmonics: Sir William D. Niven, K.C.B., F.R.S.

Royal Institution, at 5.—Internal Combustion Engines: Prof. B. Hopkinson.

Institution of Electrical Engineers, at 8.—*Adjourned Discussion*: Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Company: C. P. Sparks.—Electric Winding, considered Practically and Commercially: W. C. Mountain.

FRIDAY, March 30.

Royal Institution, at 9.—Recent Progress in Magneto-optics: Prof. P. Zeeman.

SATURDAY, March 31.

Royal Institution, at 3.—The Corpuscular Theory of Matter: Prof. J. J. Thomson, F.R.S.

MONDAY, April 2.

Society of Arts at 8.—Fire, Fire Risks, and Fire Extinction: Prof. Vivian B. Lewes.

Society of Chemical Industry, at 8.—The Ropiness in Flour and Bread, and its detection and Prevention: E. J. Watkins.—The Röse-Herzfeld and Sulphuric Acid Methods for the Determination of the Higher Alcohols.—A Criticism: V. H. Veley, F.R.S.

TUESDAY, April 3.

Royal Institution, at 5.—The Influence of Geology on Scenery: Dr. J. E. Marr, F.R.S.

Institution of Civil Engineers, at 8.—The Harbours of South Africa: C. W. Methven.—*Probable Paper*: On the Resistance of Iron and Steel to Reversals of Direct Stress: Dr. T. E. Stanton and L. Bairstow.

WEDNESDAY, April 4.

Institution of Civil Engineers, at 8.—Variations in Direction o the Wind, and an Instrument for determining them Graphically: B. F. Beverley.

Geological Society, at 8.—On a Case of Unconformity and Thrust in the Coal-measures of Northumberland: Prof. G. A. L. Lebour and Dr. J. A. Smythe.—The Carboniferous Succession below the Coal-measures in North Shropshire, Denbighshire, and Flintshire: Dr. Wheelton Hind and J. T. Stobbs.

Entomological Society, at 8.

Society of Public Analysts, at 8.

Society of Arts, at 8.—Ramie and its Possibilities: Mrs. Ernest Hart.

THURSDAY, April 5.

Royal Society, at 4.30.—*Probable Paper*: On the Physiological Action of a Recently Discovered African Arrow Poison: Dr. Charles Bolton.

Chemical Society, at 8.30.—An Improved Apparatus for measuring Magnetic Rotations and obtaining a Powerful Sodium Light: W. H. Perkin, Sen.—The Rusting of Iron: G. T. Moody.—On the Determination of Carbon in Soils: A. D. Hall, N. H. J. Miller and N. Harmer.—The Electrolysis of the Salts of ββ-Dimethylglutaric Acid: J. Walker and J. K. Wood.—Bromo- and Hydroxy-Derivatives of ββ$\beta'\beta'$-Tetramethylsuberic Acid: J. K. Wood.—Some new Orthoxylene Derivatives: G. Stallard.—A new Solvent for Gold. Preliminary Note: J. Moir.—The Molecular Condition in Solution of Ferrous Oxalate: a Correction: S. E. Sheppard and C. E. K. Mees.

Royal Institution, at 5.—Internal Combustion Engines: Prof. B. Hopkinson.

Institution of Electrical Engineers, at 8.—Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Company: C. P. Sparks.—Electric Winding considered Practically and Commercially: W. C. Mountain (*Conclusion of Discussion*).

Linnean Society, at 8.—*Exhibition*: Some Plants new to the Pre-Glacial Flora of Great Britain: Clement Reid, F.R.S.—*Papers*: A Second Contribution to the Flora of Africa.—Rubiaceæ and Compositæ, Part II.: Spencer Moore.—The Anatomy of the Stem and Leaf of *Nuytsia floribunda*, R.Br.: E. J. Schwartz.—Taiwanites, a new Genus of Coniferæ from the Island of Formosa: B. Hayata.

Civil and Mechanical Engineers' Society, at 8.—Steam Turbines: G. D'A. Meynell.

FRIDAY, April 6.

Malacological Society, at 8.—On a Species of the Land Molluscan Genus Dyakia from Siam: Lt.-Col. H. H. Godwin-Austen, F.R.S.—Descriptions of new Species of Land Shells from Peru and Colombia: S. I. Da Costa.—Note on Swainson's Genus Volutilithes: R. Bullen Newton.—Further Notes on the Genus Chloritis, with Description of new Species: G. K. Gude.—*Vertigo parcedentata*, Braun, in Holocene Deposits in Great Britain: A. S. Kennard and B. B. Woodward.

Royal Institution, at 9.—The Physical Basis of Life: W. B. Hardy, F.R.S.

SATURDAY, April 7.

Royal Institution, at 3.—The Corpuscular Theory of Matter: Prof. J. J. Thomson, F.R.S.

The Essex Field Club (at Essex Museum of Natural History, Stratford), at 6.30.—Salt-making in Essex, Ancient and Modern: Miller Christy.—Neolithic Man in Epping Forest: F. W. and H. Campion.

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