THURSDAY, MARCH 16, 1911.

THE KAISER-WILHELM SOCIETY FOR THE PROMOTION OF SCIENCE.

GERMANY, and its head, the Emperor, have again shown the world their gratitude for the achievements of science; if desired, the word gratitude may be interpreted in the sense of "favours to come." Not content with endowing the universities and technical high schools from the Exchequer with what appear to us relatively enormous sums, a society has been founded, under the "protection" of the Emperor, for the advancement of science. It is instructive to note the difference between their method and ours. Both countries possess what is called "technical education"; but while we have founded schools in considerable number, destined to capture the workmen (who seldom attend) and the prospective foremen, they have aimed at the education of the manufacturers and the works managers. Instead of numerous institutions giving elementary science instruction, they have a few, imparting the most advanced. Instead of a system of small scholarships, intended to bribe the clever children of the lower middle class, they leave it to the parents to find out that their children, suitably trained, are equipped for their lifework, and will, if they are diligent, be certain of reasonable incomes, and respectable positions.

In this latest enterprise, too, the Germans have appealed, not to the moderately well-off, but to the rich. Membership of the new society may be acquired by private persons, or by firms, on the condition of an initial contribution of 20,000 marks (1000*l.*), payment of which, by special resolution of the Senate, may be distributed over several years, and besides this, an annual contribution of 1000 marks a year, commutable by a lump sum of 40,000 marks, or 2000*l.* The members are to be elected by the Senate, a body chosen by themselves at a general meeting, which must be held once each year, in February, but may be summoned also at any time by the president, or by any two members. Members of the Senate, consisting of at least ten members chosen by the contributors, hold office for five years; to it belong other members, not necessarily donors but *Gelehrte*, *i.e.* savants, or other persons who may be deemed useful, nominated directly by the Protector, that is, by the German Emperor. The election of members by the Senate requires the Protector's confirmation before it becomes absolute. Rules exist for the resignation of members and for the removal of defaulting members. The Senate meets twice a year, and holds a statutory meeting in March; it may also be summoned at other times by the Protector, by its Executive Committee, or by request from a third of its members. It elects a president, two vice-presidents, two treasurers, and two secretaries; the election of the three first also requires confirmation by the Protector. These form the executive committee of the society.

The object of the society is designated in its title, and in its first statute; it is "to promote the sciences, especially by the foundation and support of scientific institutes of research."

Readers of NATURE will have already read a translation of the address delivered at the opening of the society in presence of its Protector, by Prof. Emil Fischer, of Berlin, printed in the issue for February 23. The daily papers have informed us that at the celebration of the centenary of the Berlin University held last October the Emperor announced that this society had at its disposal a capital of half a million sterling. It is proposed to devote its income to the equipment of institutes in which men already eminent in their respective subjects will be installed. They will have the right to take student-assistants, *i.e.* young men, who wish to graduate in one or other of the universities; they will thus be able to pursue research, aided as much or as little as they please. Such a position was held, as member of the Berlin Academy, by Prof. van't Hoff, whose recent removal by death the whole scientific world deplores. He had a free hand, was not obliged to give any formal lectures, or to take part in the active management of the University, but was allowed, with the help of students, to work out his own problems in his own way, and his work on Stassfurth salts has been of great technical value. His words to the writer were, many years ago, that he thought it right to help his adopted country to solve its commercial problems, and that he had attempted to do so. But it must be understood that no such expectation is necessarily entertained of the incumbents of chairs at the proposed institutes; the progress of *science*, not necessarily of its industrial application, is contemplated. Our neighbours have learned the lesson that science, like virtue, brings its own reward.

It is wonderful how deeply the spirit of trust in science has penetrated the whole German nation. When Prof. Ostwald, many years ago, appealed to the Saxon Government for money to build his physico-chemical laboratory, the Socialists in the Saxon Parliament voted for the grant to a man, believing that greater expenditure on pure science would contribute to greater industrial opportunities. This spirit, which permeates the German people, from the Emperor on his throne to the representatives of the peasants, causes admiration; would that it could inspire imitation!

One is led to speculate on the cause of this. Why is it that the people of Germany have such sympathy for scientific endeavour? The reasons are many.

First, and above all, is the discipline which the German people have undergone by their military training; more are thus prepared for practical life in a measure which cannot be otherwise attained. It has its disadvantages; on the whole, the people are not so self-reliant, but they become more trustworthy machines. Second, there is a deeper understanding of scientific achievements and their bearing on industry. This manifests itself in many ways; the German Government is not above asking for, and acting on, scientific advice. The social position of the savants, scientific and literary, is therefore assured, and the incomes of the higher posts compare favourably with those earned by professional men and manufacturers. This higher social standing secures attention to those who tender advice. Third, there is a constant exchange between academic and industrial posts; many men leave chairs to become managers of factories; many men enter the teaching and investigating profession from factories. Chemical and physical factories, too, there form a training school for the younger scientific experts; where many are employed, the more advanced communicate their knowledge and the results of their experience to the junior members of the scientific staff; in fact, they have apprenticeship at its best. Here, in prosperous times, the manufacturer thinks that he has no need of scientific assistance; in times of bad trade he believes that he cannot afford it. And, lastly, the process of training the people has gone on in Germany for nearly a hundred years. Rewards have been given, not to successful examiners, and not in the form of scholarships; but have been earned in the battle of life, for which ample preparation has been given.

This spirit of trust in science has permeated to the highest in the land; that it has been fertile in practical results is amply proved by the inception of the Kaiser-Wilhelm Society for the furtherance of science.

MIMICRY IN THE BUTTERFLIES OF AFRICA.

African Mimetic Butterflies; being Descriptions and Illustrations of the principal known instances of Mimetic Resemblance in the Rhopalocera of the Ethiopian Region, together with an Explanation of the Müllerian and Batesian Theories of Mimicry, and some account of the Evidences on which these Theories are based. By H. Eltringham. Pp. 136+x plates and map. (Oxford: Clarendon Press, 1910.) Price 50*s*. net.

THIS valuable work is in chief part devoted to the "Descriptions of Mimetic Associations in African Rhopalocera," illustrated by nine beautiful coloured plates (ii–x) and by a most useful map of Africa. This—the main object of the book—is preceded by an excellent introductory account of the structure and classification of butterflies, and of mimicry and its relationship to other uses of form, colour, and pattern. The introduction is illustrated by the admirable first plate, showing the characters of the fore-feet of the principal butterfly groups. The discussion of special objections to the theories of mimicry, and a consideration of the evidence by which they are supported, are wisely left to the concluding pages of the text. A useful bibliographical list and an excellent index complete the work.

The extraordinarily rapid growth of knowledge on this subject at the present day is seen in the fact that important new light has been already thrown on certain conclusions in the few months that have elapsed since the appearance of the volume. Thus on p. 31 we read of the family raised by Mr. St. Aubyn Rogers from a female *Hypolimnas misippus* somewhat intermediate between the type and the form *inaria*, and of how the females, without exception, turned out to be *inaria*. But since the day of publication Mr. Rogers has bred in the same locality, Rabai, near Mombasa, another family from an *inaria* female parent, and in this instance all the female offspring were *misippus*! It should be mentioned in connection with this hitherto unpublished result that *misippus* and *inaria* females are about equally common in the locality where the families were reared.

Again, when the book was published it was safe to assert (on p. 96) that the *planemoides* female form of *Papilio dardanus* is restricted to the areas where its *Planema* models are abundant; but Mr. Rogers has now sent an example of it from the neighbourhood of Rabai, and Mr. G. F. Leigh an evidently closely allied very rare form from Durban, the former much to the east, the latter immensely to the south of any locality from which the models have been recorded.

Then the comparatively few African examples of mimicry within the Nymphalinæ have been increased by the recent observations of Mr. W. A. Lamborn that *Diestogyna gambiae*, the female of which resembles the abundant *Catuna angustata*, is constantly to be found in the company of this species.

Our knowledge of mimicry in Africa is progressing at a very rapid rate. To name only the principal naturalists who are directing their attention to this subject at the present moment, we have Mr. A. D. Millar and Mr. G. F. Leigh in Natal, Mr. C. F. M. Swynnerton in south-east Rhodesia, Mr. St. Aubyn Rogers in the Mombasa district, Mr. C. A. Wiggins at Entebbe, and Mr. W. A. Lamborn in the Lagos district. The present writer has found it most inspiring to be associated with all these keen observers and to receive many times in each year the tidings of new discoveries and the material on which they were based.

Mr. Eltringham's work will be of the utmost assistance to these and other naturalists, and it is to be hoped that it will be available in every African centre accessible to students of nature.

It will also be clear from the brief account of the plan and contents of the work that it is certain to be quite as valuable and efficient in stimulating and guiding the beginner as in aiding the expert in the search for fresh discoveries.

A careful and critical study has revealed comparatively few mistakes. All that have been detected are mentioned below, and in a book so full of statements of fact, the list must be regarded as a short one.

In mentioning *Cethosia* (p. 39, n. 2), the Oriental mimic of *Danaida*, it would have been well to point out that we here meet with one of the very rare instances of mimicry in the male, but not in the female. The mimicry is confined to the upper surface, and can hardly be looked upon as "remarkably accurate" in any species of this genus.

The male of *Planema macarista* should have been mentioned on p. 45 as a model of the *aurivillii* form of female of *Acraea alciope*. In both shape of wings and pattern the resemblance to this *Planema* is closer than to *P. poggei*, the model given by the author—a conclusion very clearly expressed in the arrangement of plate viii., but inadvertently omitted from the text.

In discussing, on p. 52, the scanty and somewhat imperfect mimicry of the abundant Danaine, *Tirumala petiverana*, the author omits the important consideration that the species is a *recent* intruder from another area—an intruder still retaining a close resemblance to its nearest Oriental allies.

In speaking, on p. 58, of the "black and white" varieties of *Pseudacraea lucretia* approaching the Danaine model *Amauris echeria*, the author is evidently referring to the individuals in which the normal white markings are to a greater or less extent replaced by ochreous.

It would have been appropriate to place *Acraea esebria* among the mimics of *Planema aganice* and its form *montana* (pp. 73-5). Furthermore, *aganice* is not "confined to the Natal region," but occurs in south-east Rhodesia and probably much farther north along the east coast. *A. esebria*, too, is not only southern (p. 81), but eastern in distribution.

Entebbe is given as the only locality of *Pseudacraea hobleyi* on p. 78, but its female, originally described as *tirikensis*, was first collected by Mr. C. A. Wiggins in a more eastern part of the circumference of the Victoria Nyanza, viz., Tiriki and Nyangori. It has been also received from Toro.

The Pterothysanid moth *Hibrildes neavei* is not "bisexually mimetic, and corresponds to the two sexes of *Acraea anemosa*" (p. 103). The mimetic *Hibrildes* is only known as a female, which probably belongs to one of the previously known non-mimetic males.

The admirable account of the most wonderful mimic in the world, *Papilio dardanus*, is accompanied by plate x, entirely devoted to the forms of this species and the allied *P. meriones* of Madagascar. The part of the preliminary list on p. 92 would have been better, from the point of view of evolution, as well as that of geographical distribution, in the order *polytrophus*, *dardanus*, *tibullus*, *cenea*. A more serious error in the same part of the list is the inclusion of the female forms *dorippoides* and *trimeni* in the sub-species *cenea*, instead of *tibullus*, although both are correctly placed in the full account on p. 100. The male of *dardanus* is inadvertently described as black and white on pp. 93-4, although its "pale yellow ground-colour" is correctly spoken of on p. 97. The males of *tibullus* (East Africa) are characterised by the strong development of the black submarginal band in the hind wing. Those of *cenea* (South Africa) differ in the smaller development of this feature. It increases rapidly as we pass northward, the *cenea* males being transitional into those of *tibullus*. The account on p. 100 conveys a nearly opposite impression.

The classification of so complex a subject as mimicry, under the limitations imposed by the ordinary printed page, must always be a matter of great difficulty. In some respects the author has not grappled with it very successfully. Thus his admirable account of the mimics of *Danaida chrysippus* does not seem to be very happily arranged. The species follow the order of the following column, the members of no single family or sub-family being all together:—

1. *Hypolimnas misippus*: Nymphalinæ.
2. *Pseudacraea poggei*: ,,
5. *Acraea encedon*: Acræinæ.
8. *Mimacraea marshalli*: Lycænidæ.
4. *Argynnis hyperbius*: Nymphalinæ.
7. *Acraea mima*: Acræinæ.
6. *Acraea wigginsi*: ,,
9. *Cooksonia trimeni*: Lycænidæ.
3. *Diestogyna iris*: Nymphalinæ.

In spite of this dislocation of the groups in the text, we find that all four Nymphalinæ are near together on plate ii, while the three Acræinæ and the two Lycænidæ are also together on plate iii. The most obvious sequence on the plates is that indicated by the numbers to the left of the column, a sequence far better than that adopted in the text. It is, in fact, the best possible arrangement, except for the position of *Argynnis hyperbius*, which, being restricted in Africa to Abyssinia, is best placed at the head of the list—as far as possible from all the rest. It would then be followed by the wide-ranging *H. misippus*, the only Nymphaline mimic with which it is associated. The remaining seven species, together with *H. misippus*, form a very natural group, some of them wide-ranging, the others, except the more equatorial *A. wigginsi*, especially characteristic of northern Rhodesia.

Having in view the needs of naturalists who are beginning the study of mimicry in butterflies, and we hope that large numbers of them will seek the valuable and important help offered in this beautiful work, it would have been advantageous to make the group-names a prominent feature in the descriptions of the plates, and also to print comprehensive descriptive titles beneath the plates themselves and above the descriptions of each. Thus plate ii. might have been briefly explained as "*Danaida chrysippus* and its Nymphaline Mimics." The arrangement of models and mimics in separate columns in the description of the plates is an admirable feature, as also is the printing of the names of the species beneath the figures on the plates themselves.

The succession of the models in the text might also, we think, be improved. Thus the deeply interesting series of Planemas with *Pseudacraea* mimics, begun on p. 65, is interrupted (pp. 66-9) by the great black-and-red combination ranged round *Acraea egina*, and by the purely Nymphaline association of *Crenis* and *Crenidomimas* (p. 70), and then again resumed on pp. 70, 71, *et seq.*

The author has wisely preceded his account of mimicry by a classification, on pp. 11, 12, of the chief butterfly groups, with a few of the main features by which each is distinguished. Such a classification will be of great value to those who are beginning the study of mimicry in the field, and have not the means of referring to the literature of the subject. It is a pity, however, that the Brassolinæ and Morphinæ are separated from their close allies, the Satyrinæ, by the intercalation of the Acræinæ and Heliconinæ—these latter being themselves similarly cut off from the Nymphalinæ, to which they bear so close an affinity. The author is here following in the main the key given by Mr. Roland Trimen in his South African Butterflies; but in this great work a linear arrangement based on affinity is printed on the opposite page, and is adopted throughout the volumes.

It is also unfortunate that the division of the "Heliconidæ" of Bates into Ithomiinæ and Heliconinæ is recognised neither in the classification nor in Mr. Eltringham's further discussion of the groups on pp. 17, 18. The composite nature of the "Heliconidæ" was fully accepted and explained by Bates in his paper on mimicry, where he speaks of the "Danaoid" and the "Acræoid" Heliconidæ. And since Bates's time the strong difference on which he insisted has been further emphasised by creating a separate Nymphalid sub-family, the Ithomiinæ or Neotropinæ, for the larger group, the "Danaoid Heliconidæ." *Ituna* and *Thyridia* are mentioned on p. 18 as belonging to the Danainæ; but the latter genus is Ithomiine, as Fritz Müller proved in 1879; and the author's argument in favour of mimetic approach is much strengthened by the great width of the interval between it and *Ituna*. The omissions and errors in this and the last paragraph are, however, concerned with tropical American butterflies, and do not greatly affect the value of a work on African Rhopalocera.

The author's arguments are clear and convincing, and he handles his intricate subject with great skill. The following line of reasoning is, however, open to criticism.

Speaking of the female of the Oriental *Argynnis hyperbius*, which, over nearly the whole area of its distribution, mimics *D. chrysippus*, but in Australia resembles its own male, and is non-mimetic, the author concludes:

"Since it has become established in Australia before the advent of the Danaine, mimicry of the latter is unnecessary for its continuance."

We are not convinced that this reasoning is sound. It may well be that the representative of *D. chrysippus* has not existed in Australia for a sufficient length of time for the mimicry to have originated; but the above argument seems to imply that a well-established indigenous form would never be influenced by an invading model. There is good evidence that such a change is ultimately wrought, as we see in the effect of the Old World Danaidas upon the North American *Limenitis* (*Basilarchia*), and of the Oriental Tirumalas (*Melinda*) upon the Ethiopian Papilios, so beautifully illustrated by Mr. Eltringham on plate iv of the present work. If these Danaines had not invaded the areas of which we speak, there is little doubt that the species of *Limenitis* and *Papilio* would be still living, but of course without their present mimetic patterns. A certain average proportion of destruction takes place in every generation. The advent of a dominant Danaine model does not necessarily alter this proportion numerically, but affects its quality. Whereas variations in the direction of the model were previously distributed at random among the eliminated and the survivors, they now tend, in each generation, to be more thinly scattered in the former set, more thickly in the latter. And the same conclusion holds for every step by which an elaborate likeness is finally produced.

The above considerations doubtless supply at least in part an interpretation of polymorphism in mimicry—the fact that a single mimicking species often appears in two or more quite different forms resembling different models. For when—by the spread of either itself or the mimic—a new and dominant model, A, comes into relationship with the mimic of an older model, B, the same conclusion holds. The eliminated proportion of the mimic will now for the first time tend to contain less, the surviving proportion more, of any variation in the direction of A, and after a time the mimic may resemble both A and B. Often, but by no means always, such a process is transitional, affording the means by which the mimic finally comes to resemble A in one part of its range, and B in another. A good example is to be found in the female of *Acraea alciope*—a tangled problem most skilfully unravelled by Mr. Eltringham not many months ago. The usual western female of this species mimics the common pattern of the western male Planemas. Further east, at Entebbe, this pattern, although it occurs, is by no means dominant, and the ordinary form of female *alciope* mimics the male of *Planema macarista*, and both sexes of *P. poggei*. But rare examples of the western mimic are still to be found among the *alciope* females at Entebbe, and of the eastern mimic on certain parts of the west coast. The probability that the younger mimetic pattern—almost certainly the eastern—has been reached through dimorphism, is extremely strong.

The author alludes to this deeply interesting subject of polymorphism in mimicry—shown by the recent researches of Dr. Karl Jordan to cover a far wider area than has been hitherto supposed—and infers on pp. 62, 63 that the only interpretation is to be found in Bates's hypothesis of a palatable mimic resembling a distasteful model:

"We are forced . . . to the conclusion that species which in the same locality produce polymorphic mimetic forms are Batesian mimics, and that the value of the multiple varieties lies in the distribution of the mimetic forms amongst a corresponding number of models, thus avoiding the risk of the edible mimic becoming more numerous than its distasteful model, a state of things which would lead to a disastrous increase in the amount of experimental tasting by insectivorous animals."

In other parts of his work the author himself compels us to doubt the cogency of this reasoning, for he figures and describes such polymorphic mimics among the highly distasteful Acræas—for instance, *A. jodutta*, with its two forms of female at Entebbe, and the wonderful series of mimetic patterns exhibited by *A. johnstoni* in British and German East Africa.

There are a few typographical errors, such as "survivials" on p. 23, which we should scarcely have expected in a book produced by the Oxford University Press, and should also have anticipated that its excellent readers would have directed the attention of the author to an awkward slip in the construction on l. 7 from the bottom of p. 78, as also to a few "split infinitives" scattered through the pages.

The abundant names of species and genera have been very accurately printed. We notice only a single error—*Pseudobazis* for *Pseudohazis*, on p. 118. Among names of persons *Guillème* is printed for *Guillemé*.

Mr. Eltringham's monograph is the first attempt to set forth a nearly full account of mimicry in the butterflies of one of the great tropical regions. He has very wisely selected Africa for his purpose. Its examples are far more numerous and perfect than those of the Oriental region; yet they are manageable and not bewilderingly complicated like those of tropical America. Africa, too, is especially rich in naturalists who are waiting to be inspired and encouraged, as they will assuredly be by the present work. The author is to be congratulated upon the fine volume and the beautiful plates which are the outcome of his labour of love. It cannot be long before he may be congratulated upon their fruitful results. E. B. P.

THE GEOLOGY OF EGYPT.

Geological Map of Egypt. Scale 1 : 1,000,000 (six sheets) and reduction of the same to the scale 1 : 2,000,000. (Cairo: Survey Department, 1910.)

SOON after the occupation of Egypt by a British military force in 1882, the late Prof. Huxley, then president of the Royal Society, directed attention to the valuable opportunity that was afforded for the extension of our geological knowledge in that interesting country. He instanced the valuable series of scientific memoirs that had been prepared by French savants during the occupation of the country at the beginning of the nineteenth century, as an example worthy to be followed. Following his advice, the Royal Society appointed a "Delta Committee" to arrange for explorations, which it seemed desirable to undertake, and made various grants from its funds to defray expenses. The War Department of the Government, on being applied to by the Royal Society, agreed to lend the service of some of the engineer-officers, then in the country, to supervise the work.

As the result of these arrangements, borings were put down at a number of points in the Nile Delta, and reports on the materials sent home were submitted to the society by the Delta Committee in 1885 and 1897, and were published in the Royal Society Proceedings.

But in 1893–4 an engineer-officer, Captain H. G. Lyons, already known in this country by his geological work in the Bagshot area, was employed on patrol work in the oases of Kharga and Dakhla and in the desert routes to the south of them, and he took the opportunity thus afforded to him for making a number of geological observations in the district, which proved to be of great value and interest. Two years later the Egyptian Government decided to establish a geological survey of the country, and to place it under the direction of Captain Lyons. A staff of surveyors was formed, consisting of four young geologists from the Royal College of Science—Messrs. Barron, Beadnell, Hume, and Ball—and for a time Dr. Blankenhorn acted as palæontologist to the survey. The first named of these surveyors, after doing much excellent work, fell a victim to the climate of the Sudan in 1906. A number of very valuable memoirs by Captain Lyons and his staff have been published, some of which have been already reviewed in the pages of NATURE.

As Egypt and the Sudan have no good topographical maps to be placed at the disposal of the geological staff, topographers have had to be attached to each of the geological surveying parties; in this branch of the work Mr. F. W. Green, of Cambridge, a good archæologist, has often served as a volunteer. In 1898 Captain Lyons took over the charge of the whole of the survey departments of Egypt, while continuing his direction of the geological work.

It is not possible here to enumerate all the advances made in our knowledge through the labours of the little staff of geological surveyors in Egypt, but especial mention may be made of the important palæontological discoveries of Mr. Beadnell, aided by Dr. Andrews, in the Fayum, which included the finding of the wonderful Arsinotherium, and the ancestral forms of elephants and whales. Scarcely less interesting and important are the results obtained by Dr. Hume in his surveys of the Sinaitic peninsula, and of the eastern and south-eastern deserts of Egypt; and by Dr. Bell in his work around several of the oases and cataracts.

The results of all these researches are incorporated in the new geological maps of Egypt now issued. In spite of the existence of considerable blanks, these maps are a very great advance on any that have hitherto appeared. The oldest fossiliferous formation recognised is the Carboniferous, but considerable areas have to be mapped as "Nubian sandstones," portions of which may be of different geological age; there are also beds of gypsum, the position of which in the geological series is in some cases still doubtful. The Cretaceous strata are divided into Cenomanian, Senonian, and Danian, while the extensively developed Eocene strata have been distributed in three local divisions. Strata referred to the Miocene and Pliocene also occur, while Pleistocene and more recent deposits obscure wide areas. The larger-scale map forms six sheets, and the smaller a single sheet; all these are admirably printed in colour, and corresponding maps with hill-shading have also been issued by the Survey Department.

The survey staff has lost its original director, Captain Lyons, and also Mr. Beadnell, but it has been reinforced by the appointment of Mr. H. T. Ferrar, the geologist of Captain Scott's first Antarctic expedition; there have also been several other geologists who have served temporarily on the staff. The work is carried on at the present time under the directorship of Dr. W. Fraser Hume, who has had such a wide experience in desert-work, and is responsible for the maps which form the subject of the present notice. We are glad to learn from the last issued report of the survey that Dr. Hume proposes to write a general sketch of the "Geology of Egypt," this work, from such capable hands, will be looked forward to by geologists with much interest.

J. W. J.

THE BEGINNINGS OF BOTANY.

Landmarks of Botanical History. A Study in Certain Epochs in the Development of the Science of Botany. Part i., Prior to 1562 A.D. By E. L. Greene. Pp. 329. (City of Washington: Smithsonian Institution, 1909; Smithsonian Miscellaneous Collection, part of vol. xliv.)

DR. GREENE has contributed to the history of the progress of botany a work that bears evidence of unwearied research into the labours of botanists whose influence on the science is realised by few, and whom it is well to remember with respect and gratitude. The book is wholly devoted to the early beginnings of the knowledge of plants, and to the revival of their study in the fifteenth and sixteenth centuries. It is not a work to be taken up to pass a leisure half hour. One feels disposed at times to question the author's presentation of his subject, but when the book has been read through one feels that it has well repaid the effort in the suggestive lights it has thrown on the past, on problems that are still with us, as well as on others that are no longer problems because solved for us by those early botanists. The treatment of the subject makes this book a valuable complement to the well-known "History of Botany" by Prof. Sachs, and there is much additional information in it.

Dr. Greene frequently is drawn into philosophical discussions in the definitions of his subjects. He defines the science of botany for the present work as occupied with the contemplation of plant as related to plant, and with the whole vegetable kingdom as viewed philosophically—not economically or commercially—in its relation to the mineral on one hand and to the animal on the other. From this point of view he recognises the beginnings of the science in the study of plants as plants, apart from their real or supposed economic worth. He finds true botanical science in the natural groups of popular language, and even in such terms as "herbs," "trees," and "grass," and still more clearly in such as "clover," "oak," &c. The correlation in value or kind of these and the like with the "genera" of systematic classification is insisted on. He concludes his introduction with impressing the view that "the essence and substance of botany proper are organography and the logical deductions we may draw from organography. The line of development of organography—as including terminology—is that along which a truly coherent and philosophic account of botany must be written."

A brief chapter is devoted to the Rhizotomi, whose maxims—so readily condemned as superstitions—he gives reasons to regard as in many cases judicious and well-founded.

By far the greater part of the book is occupied with brief biographies and detailed consideration of the work of five writers: Theophrastus of Eresus, Otto Brunfels, Leonhard Fuchs, Hieronymus Bock (Tragus), and Valerius Cordus. Short chapters on Greek and Roman writers after Theophrastus, on the early German writers, and on Euricius Cordus, father of Valerius, complete the volume.

Few botanists can claim to have gained a knowledge from his own writings of the part filled by Theophrastus in the progress of botany. To most Dr. Greene's estimate of his work will prove a revelation of a very surprising kind. The minute and careful analysis of the information contained in the two books that have survived, in an unfortunately imperfect state, shows that he was a genius and investigator far in advance of other botanists of his time. A recapitulation is given at the close of the chapter indicating seventeen heads regarded as "elements of universal botany of which Theophrastus appears to have been the discoverer and first promulgator." While it may be felt in regard to some of these that Dr. Greene is disposed to press the point unduly, the larger part are of such importance as to justify the claim to a front rank among botanists, and to show the inadequacy of the judgment expressed on him in Sachs' book.

Brief notices of Dioscorides, Varro, Virgil, Pliny, Galen, and others, bring out the contrast of these with Theophrastus, their inspiration being chiefly the study of plants for their useful or harmful properties, though they also added at times to the knowledge of plants as plants. During the long period of more than twelve centuries after the time of Galen, the natural sciences, instead of advancing, fell much into decay, and were in part represented by such works as the "Ortus Sanitatis," filled with grotesque figures and strange perversions of the truth.

The reawakening from this condition is placed by German historians of the science, such as Meyer and Sachs, in the sixteenth century, when the "Herbarum Vivæ Icones," of Otto Brunfels, was issued, and was succeeded by, among others, the works of Fuchs, Tragus, and Valerius Cordus. Brunfels and Fuchs, he points out, busied themselves almost wholly with plants as medicinally valuable; and their books are little more than compilations illustrated by figures of the plants to which they believed their borrowed descriptions referred. These figures were excellent in comparison with those in use previous to Brunfels; but in other respects neither Brunfels nor Fuchs can be shown to have made any important step forward. Fuchs introduced his "Historia Stirpium" with "An Explanation of Difficult Terms," from which his views on the structure of plants can be gathered, and are found in general to be retrograde from those expressed by Theophrastus.

Bock or Tragus (1498–1554) had a different point of view from Brunfels and Fuchs, and may deservedly be accepted as having opened the new era of botany. He studied plants for their own sakes; and, possibly in part from inability through poverty to employ illustrations in his "New Krauterbuch," he sought to describe them so clearly as to make it possible for others to recognise them from the descriptions alone. He wrote his books in German instead of the customary mediæval Latin; a translation into Latin being afterwards issued for use in other countries. He merely names the common and well-known plants, describing the scarcer and previously unknown forms. His method required, and was based on, very careful personal investigation; and he thus was able and was led to make important contributions to the science in various directions. Dr. Greene discusses Tragus's views on classification, nomenclature, ecology, &c., very suggestively and justly, with full recognition of his great merits but also calling attention to errors.

Euricius Cordus is given a place of honour for his sole botanical work, in which he points to defects in the study of botany in his day, but still more as the father and teacher of Valerius Cordus. The latter died at the age of twenty-nine, while travelling in Italy, but had won reputation by a work on the preparation of medicines published during his lifetime.

He had travelled extensively in remote parts of Germany, had discovered many more plants than had been made known since the revival of botanical study in Germany, and had described these carefully in a work, "Historia Plantarum," left in manuscript. This was published some years after his death, edited by Conrad Gasner, who, by desire of the publisher, employed illustrations (prepared to accompany Tragus's work) to illustrate the descriptions of Cordus, to which they were occasionally incorrectly fitted. From a careful study of the descriptions, Dr. Greene shows cause to regard Valerius Cordus as of rare ability and insight, and esteems him to have been immeasurably the greatest of the "German fathers of botany." Among the services to botany ascribed to him we are told that "he is the inventor of the art of phytography"; that in all descriptions "attention is given to the morphology and life-history of the plant in as far as is known to him"; that new terms are employed expressing new ideas and points of view in the science, and that new conceptions appear in regard to inflorescences, flowers, fruits, and seeds. In taxonomy he shows clearer views with regard to species, and his groups were more often based on relationships than were those of his predecessors. A number of his groups of generic rank stand good, though in most cases the names given by him were needlessly changed by Linnæus. He paid heed to internal structure (so far as that could be determined by him, that is, by the unaided eye), and to physiology, as regards prefloration, modes of climbing, and similar features of plant-life. He also gave attention to the varieties of cultivated fruits, of which excellent descriptions are extant by him. What he succeeded in doing suffices to show how grievous a loss botany sustained in his early death.

VECTOR ANALYSIS.

Éléments de Calcul vectoriel, avec de nombreuses Applications à la Géométrie, à la Mécanique, et à la Physique mathématique. By Prof. C. Burali-Forti and Prof. R. Marcolongo. Édition française traduite de l'Italien et augmentée d'un Supplément par S. Lattès. Pp. vi+229. (Paris: A. Hermann et Fils, 1910.) Price 8 francs.

THE variety of matter contained in this small book shows the condensing power of vector notation, especially when combined with a concise literary style. The theoretical part includes the elements of the barycentric calculus, as well as a vector analysis in which vectors are written either in single letters, or in the form B–A, where A, B are points. Scalar and vector products are treated separately, so that quaternions do not come in. Special points to notice are that a scalar product has given to it the sign opposite to that assigned by Hamilton; the effect of this is that if α, β, γ are three orthogonal unit-vectors, $\alpha^2=\beta^2=\gamma^2=1$, and versors have to be treated by introducing a symbol i, such that $i^2=-1$, and is *not* a vector. There is a good deal to be said for this; but it is most unfortunate that the authors take the clockwise sense of rotation for the positive one, especially considering the use of vectors and vector products in physics.

The applications include geometrical, mechanical, hydrodynamical and electrical formulæ. Specially to be noted are the proofs of Green's theorem and its congeners, Stokes's theorem of circulation, and Hertz's formula for variation of flux.

There is an appendix, partly historical, partly critical and even polemic. Probably every reader will find something here with which he cordially disagrees; but there is one statement that deserves special attention. We believe that the authors are right in thinking that the final notation of the vector calculus will be based on Grassmann's "Ausdehnungslehre," as improved and modified by subsequent writers. The Hamiltonians will have nothing more than a sentimental grievance if this proves to be the case. Nothing can upset, or even modify, the quaternion calculus, because it is a definite type of linear algebra; the main question now is whether *this* algebra is the best for the treatment of physical, and especially electrical, problems. Judging by the attitude of Gibbs, Heaviside, and Lorenz (to name only these), the answer appears to be no.

There is very little fear that a really convenient notation will not be ultimately agreed upon; it will probably be invented by a physicist. Meanwhile, dispassionate observers will derive some amusement, as well as much instruction, from the lively controversies of the champions of this or that particular symbol, as if its retention or rejection were of vital importance in itself. For instance, our authors seriously object to a symbol such as $[\alpha\beta]$ for a scalar product, on the ground that functional symbols are invariably placed on one side of the operand! The example of $\int y\,dx$, where $\int()dx$ is practically a functional symbol, shows that the statement is barely true, except in an artificial sense; but even if it were strictly true, this would be no reason for regarding it as a necessary law of mathematical notation.

G. B. M.

MAP-MAKING.

The Theory of Map-Projections, with special reference to the Projections used in the Survey Department. By J. I. Craig. Pp. iv+80. (Cairo: National Printing Department, 1910; Ministry of Finance, Egypt Survey Department.) Price 200 milliemes.

THE subject of map projections is one in which the English language is strangely deficient, a deficiency the more apparent when contrasted with the wealth of Continental literature on the subject. Those interested in the higher theory of map-making will, therefore, welcome the appearance of this little treatise, which seems to give in a compact and practical shape all the essentials of this attractive branch of the geometry of surfaces. Starting with a statement of the problem to be solved, and an allusion to possible improvements in nomenclature; the term projection itself, in the meaning of a representation in accordance with any law, for instance, is not a particularly happy one; a history is given of the adoption of the Gauss conformal meridional projection for the maps of the survey of Egypt. A general discussion of the figure of the earth, and the geometry of the surface of a spheroid, is then entered upon, leading the way to the theory of the representation of such a surface on a plane sheet and the involved balancing of errors. These general results are then applied to the standard projections, so that, while special attention is devoted to the Egyptian mapping, the major part of the book is of quite general application. The methods of investigation are, in many cases, new, and the mathematical forms concise and elegant.

As an interesting example of specialisation, we may note the investigation, on p. 61, of the Mecca retro-azimuthal projection, which would provide a map giving the true bearing of Mecca at any point.

The great variety of projections used for the maps of different countries gives rise to certain inconveniences, and it is an arguable point whether it would not be possible and desirable to reduce this number to a few standard forms by international agreement. What has already been accomplished in the case of the 1/1,000,000 map of the world might be extended to apply to other scales. We commend the subject to the attention of the next International Geographical Conference. It must always be borne in mind that while the selection of a suitable projection is important for atlas or general maps upon small scales, it is comparatively unimportant for large-scale survey maps produced in sheets, so long as each sheet is projected separately. The errors due to defects in the projection are always small compared with those due to the distortion of the paper upon which the map is drawn or printed.

E. H. H.

OVERHEAD AND UNDERGROUND ELECTRIC LINES.

Lignes Électriques Souterraines. Études, pose, essais, et recherches de defauts. Pp. 207.

Lignes Electriques Aériennes et Souterraines. Études, pose et essais. Pp. 181. By C. Giradet and W. Dubi. (Grenoble: J. Rey; Paris: Gauthier-Villars, 1910.) Price 5 francs each.

THE superscription on each of these volumes: "Bibliotheque de l'eleve-ingenieur," seems to indicate that they are written by and for graduates of engineering colleges, and this impression is confirmed by an introduction contributed by Prof. J. Pionchon, of the Dijon University, in which we are told that the "library" is intended to form a kind of post-graduate instruction to engineering students. To expect students shortly after they have graduated to be able to become authors on technical subjects and write books, which shall be good enough to serve as further instruction to other students which may graduate a year or two later, is hardly reasonable; but in the present case the difficulty is partly overcome by the circumstance that one of the authors is not a student fresh from college, but evidently a man of considerable practical experience in overhead power-lines and cable work.

Yet the result of the collaboration is rather disappointing. The books are neither scientific—in the sense of showing the connection between engineering practice and scientific principles—nor are they very practical in the sense of containing definite instructions. There is a little of each, and a good deal of what may be described as general talk on the subject, and containing little which is not self-evident to a man of average intelligence. Thus, when the authors tell us that overhead power-lines should be so constructed that copper may be added as the demand for power increases, everybody will agree, but is it necessary to labour so obvious a matter? On the other hand, some of the general talk is misleading. Take the statement that cables for very high pressure have no practical importance, since cables are only used within towns, that is, over relatively short distances; or the recommendation to earth the middle wire in a three-wire system at every junction box. Then, again, we find ten pages of what may be called general talk about various junction boxes, but not a single drawing to illustrate the types discussed; whilst the important matter of mechanical protection of cables is dealt with on only two pages, and illustrated by two small scale sections, one showing bricks laid over the cable longways and the other showing them broadways.

The most elaborate technical part of the book on underground lines is that on localisation of faults, and here, by the preface, we are led to expect specially valuable information; for the authors say in it that although the methods given in "some text-books" are sufficiently well known, yet their practical application under the varying and difficult condition of actual service, demand special elaboration. This is certainly true, and one turns with eager expectation to the chapter in question in order to see what the authors have to say about these special devices. Here again we are rather disappointed; although the author who has contributed this part is certainly a man who knows his subject well, and gives a series of practical and numerical examples evidently culled from his practice, one does not find much which may be considered as new methods. Our old friend the loop test crops up in various guises, and when we are told that a special wire must be run where no sound cable is available to complete the loop, the advice is, no doubt, quite serviceable, but it can hardly be considered as an advance upon the text-book method; it is simply an obvious way of carrying it out.

For the localisation of a break in the conductor a method based upon measurement of capacity is recommended. This also is old. Most engineers will expect that when a cable parts bodily the insulation at the break will also be destroyed, so that a method based on the measurement of capacity becomes inapplicable; but, curiously enough, the authors give a case from their experience where the insulation had remained perfect. The history of this breakdown, and of the expedients employed to keep the service up under a variety of great difficulties, is very interesting reading, whilst the fact that the engineers were able to locate the break within a few yards is a striking vindication of a method which at first sight seems of doubtful value. What the authors have to say about the legal aspect of overhead lines applies to France only; but their remarks on wayleave, compensation to landowners, organisation of working parties, establishment of work-places for the manufacture of ferro-concrete masts at various parts of the line, the transport of these masts, their erection, and other matters of an administrative nature, is well worth reading, and is, with but slight modifications, also applicable to similar work when done in this country.

GISBERT KAPP.

OUR BOOK SHELF.

Facts and Fallacies regarding the Bible. By W. Woods Smyth. Pp. x+208. (London: Elliot Stock, 1911.) Price 3s. 6d. net.

MR. WOODS SMYTH aims at showing that modern scientific knowledge is in agreement with Divine revelation as recorded in the Bible. He considers that the Mosaic account of the creation of worlds and of the various forms of life up to man should be accepted as an authoritative and accurate statement of inorganic and organic evolution. "The sober truth is," he says, "that wherever the Bible touches upon questions of science it does so with a grace, an accuracy, and a philosophic perfection which surpasses every text-book of science in existence."

This position is clear enough, and we cannot but admire the author for his courage in occupying it in spite of the difficulties involved. We believe, however, that he will not find supporters among theologians who know most of the origin of the Scriptures or among philosophers who are best acquainted with the facts of nature. If all scientific knowledge and theory of to-day can be shown to be only a confirmation of the Biblical record, what will be said a hundred years hence, and what was the case in the time of early Greek philosophers? Science is progressive, and the accepted views of one generation become the discarded lumber of another.

Unless, therefore, the Bible is regarded as containing all scientific knowledge for all time, there is not much purpose in showing that science and revelation are in agreement at a particular epoch, even assuming this to be the case. A more reasonable view to take is that the Scriptures are faithful historical records of what was thought or believed when they were compiled, containing observations of obvious phenomena only, and interpretations appropriate to the period in which they were made. Any attempt to show that the facts of modern science can be confirmed by reference to an inspired literature must depend upon special pleading for its case, and can do little to further the desire "to restore the Bible to its high place of authority by restoring faith in the subject-matter of the Divine revelation."

"I Wonder" Essays for the Young People. By the writer of "Confessio Medici." Pp. 109. (London: Macmillan and Co., Ltd., 1911.) Price 3s. 6d. net.

THE young people to whom the author refers on the title-page of this book must be of a metaphysical frame of mind to be able to read these essays with interest and intelligence. The subtle reasoning occasionally involved requires careful thought for its comprehension, and is best appreciated by the adult philosopher. A fine distinction on the use of the verb "to wonder" is made in the first essay. "Make up your mind," says the author, "that you will only wonder at," and do not wonder if, is, when, or where. But the verb signifies to doubt or expect as well as to marvel; so that the advice given need not be taken literally. There is a useful lesson in the second essay, which aims at showing that many attributes of things exist only so far as our senses are able to appreciate them; but it will be lost on most young people. Other essays deal with the wonder of nature, of self, of pain, of death, of beauty, and the use of wonder.

It is scarcely correct to say that "there are gases to which the air is as paving-stones to feathers," or that the something—signifying the ether—which exists throughout space "is one and the same energy, manifest in all things." If, as the author says, "it takes a fellow of the Royal Society to think of the inter-stellar ether," it may be said with equal approach to accuracy that membership of the Aristotelian Society is desirable to appreciate the points of some of his essays. The book has, however, the merit of fine style and noble thought, and provides an admirable antidote to the influence of overmuch attention to materialistic affairs.

Das biologische Schullaboratorium. By Dr. W. Schoenichen. Pp. 67. (Leipzig: Quelle and Meyer, 1910.) Price 1.60 marks.

IN this pamphlet Dr. Schoenichen gives an interesting account of the structural arrangements, equipment, and course of study in the biological department at the Helmholtz "Realgymnasium" in Schöneberg. The author passes rather lightly by the courses of general zoology and botany, though there is abundant internal evidence that these subjects are accorded a generous and judicious treatment. His main purpose appears rather to be to lay stress upon the hygienic value of biological study as a subject of general education. In this country a certain hazy conception of spores, germs, bacilli, bacteria percolates through the medium of the daily Press into the mind of the man in the street, but neither he nor his wife has any real knowledge of the "why" and the "how" of personal or domestic hygiene. About half of the present treatise is more or less directly concerned with this aspect of biology, and accordingly we find full accounts of a few of the more common species of moulds, of nutrient media, and the various appliances employed in connection with them; of the process of sterilisation and the production of "pure" cultures. A prominent place and full description are given of Prof. Lindner's ingenious "roll-cylinders," and of their employment in the biological analysis of air, water, &c., and his method of "drop-culture" is well explained and illustrated.

The concluding pages are devoted to a brief survey of the biological courses at ten of the German universities.

What will the Weather Be? The Amateur Forecaster's Vade Mecum. By H. G. Busk. Pp. 27. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1911.) Price 6d. net.

THIS little manual is intended to enable the non-scientific reader to forecast the weather, for a day in advance, from his own observations. Tables arranged under the principal wind directions show the average conditions of weather to be expected in winter and summer, with changes of barometrical pressure. The work is accompanied by a useful introduction by Mr. H. B. Stone, explaining the usual sequence of weather in areas of high and low atmospherical pressure; it is this principle that lies behind the tables, and may enable a forecaster to obtain "reasonable accuracy" by their use. More accurate forecasting depends upon the tracks actually being taken by cyclonic disturbances and other considerations, including the configuration of the ground.

LETTERS TO THE EDITOR.

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

The Non-simultaneity and the generally Eastward Progression of Sudden Magnetic Storms.

UNDER the above heading, Dr. L. A. Bauer contributes to NATURE of March 2 a letter of five columns. Referring to his Table II., p. 10, he says:—"It will be noticed that Kew is not included, for the simple reason that although Dr. Chree scaled the required data some months ago, he has not yet published them nor forwarded them to me"; and later he adds:—"Dr. Chree could not have done better than immediately to have published his own data in the same open manner that Mr. Faris had done. Instead, he labours to discredit the Coast and Geodetic Survey observations, and withholds his own from public scrutiny. In half the interval of time between the first and second presentation of his paper, had Dr. Chree chosen, he could have had at his command data from Europe and Asia which, combined with his own, would have served admirably to have tested the main contentions." The real facts are as follows. In July, 1910, I consulted the Kew curves for the dates of the fifteen disturbances treated by Mr. Faris and Dr. Bauer, and, as stated in the paper read before the Physical Society (Proc., vol. xxiii., part i.) on November 11, "I was able to identify ten of the fifteen disturbances with reasonable certainty." The measurements I then took were confined to the times of commencement of these ten disturbances. Dr. Bauer's request for data, which reached me in January, included, not merely the times, but the amplitudes of all the movements. I supposed, mistakenly, as it proves, that before publishing anything Dr. Bauer would await the data from the more remote stations, which could not well reach him in less than two or three months. I thus gave precedence to official work of urgency. Also, to get the best results possible, I had an independent set of measurements made by my chief assistant, and took a fresh set myself, and considered carefully all cases in which the times obtained differed by more than one minute, the limit of accuracy I hoped to attain. In a good many cases I was doubtful which of several small movements was the one intended, so curves were drawn indicating the movements and times, and amplitudes were given for the various alternatives. The results of this very considerable labour were dispatched to Dr. Bauer on February 25, no hint having meantime been received from him that the data were urgently wanted.

The charge that I laboured to discredit the Geodetic Survey observations is equally unjustifiable. As anyone who reads my paper will readily recognise, my criticisms were directed, not against the observational data—which, I may say, struck me as quite up to the usual standard of observations—but against the use made of them. In bringing forward these criticisms, I hoped to do better service than by collecting a number of other miscellaneous data, affected by similar uncertainties, the course which Dr. Bauer thinks it was my duty to adopt.

As Dr. Bauer takes no notice of my criticisms, I should like to indicate briefly their nature, to assist the comprehension of your readers.

Mr. Faris deduced times of commencement and corresponding velocities of propagation from Horizontal Force (H), Declination (D), and Vertical Force (V) curves separately. On the average, the H times preceded the D by 0·44 and the V by 2·3 *minutes*. I indicated the improbability of the disturbing force commencing with a component along one only of the three fundamental directions at a station. Normally, one must expect components in all three directions; thus systematic differences in the times of occurrence in the D, H, and V curves can hardly be real. To be visible, a disturbance must attain a certain amplitude. So-called "sudden commencements" really take several minutes, as a rule, to reach their maximum, and the apparent differences in time mean, presumably, differences in the amplitudes of the three components, or difference of sensitiveness in the three magnetographs. The neglect of this point of view may lead to serious error. To see this, take a simple case. Suppose a number of similar compasses to be placed on a straight line radiating out from an electromagnet. Suppose each needle frictionless, but its displacement imperceptible until it attains 1′. Let, now, a slowly increasing current actuate the electromagnet. As the current rises, movements become visible in one compass after another, and an unscientific observer might infer that a disturbance was being propagated outwards from the magnet with a velocity which might be very small if the current increased very slowly. The time, however, when any compass is visibly affected is determined, not by the velocity of propagation of electromagnetic waves, but by the sensitiveness of the needle, its orientation, and the rate of increase of the current actuating the electromagnet. Disturbances of the type selected by Mr. Faris are usually largest in H and least in V, and it thus appeared to me highly suggestive that the times derived from the H curves were so markedly the earlier. The tendency in all cases must be for the time shown to be late, the error being greater the smaller the disturbance and the less sensitive the magnet. If, then, on any given occasion, a disturbance nowhere large were smaller in Europe than America, we should expect the time of commencement shown by the average European magnetograph to be a little behind that shown by the average American instrument.

Another criticism I made was this. Originally—so far as I could understand—Dr. Bauer and Mr. Faris assumed differences in times at any two stations to depend only on differences of longitude. This implied that the disturbance travelled either due east or due west, appearing simultaneously at all places in the same longitude. Five American stations were arranged in two groups, the mean longitudes (79° 9′ W. and 146° 42′ W.) of these being regarded as belonging to two central stations 68° apart. Call these two imaginary stations A and B, the former being the nearer to Greenwich. It was recognised by Mr. Faris that a disturbance travelling, say, westwards, might pass A first, reaching B after travelling 68°, or it might pass B first, reaching A after a journey of 292°. In the former case it originated in the wide zone, 267°, separating the extreme stations Honolulu (158° W.) and Porto Rico (65° W.); in the latter case it originated in the narrow zone, 40°, separating Baldwin (95° W.) from Sitka (135° W.). The peculiarity I dwelt on was that no fewer than nine out of the fifteen disturbances were treated as if originating in the narrow zone, whereas one would have expected only two or three. Dr. Bauer does not refer to this point, but the method he now follows seems different. He again takes two central stations, this time one in America, the other in Europe, but he determines the velocity, apparently, not from the difference of longitude, but from the arc 75° on the connecting great circle. Further, he tacitly assumes that all the disturbances commence in the wide zone between the westmost American and eastmost European station, as all are assumed to traverse the 75° arc and none the 285° arc. This may or may not be a better plan than that first adopted, but it is totally different. A hypothesis which makes all the fifteen storms originate between Honolulu and Katharinenburg is obviously incompatible with one that makes nine out of the fifteen originate between Baldwin and Sitka.

Dr. Bauer's second method would avoid the difficulty I pointed out of supposing that the velocity near the poles is not merely moderate, but actually small. It has, however, this obvious drawback, that it cannot give a true velocity at all unless we suppose the disturbances to actually travel along one particular great circle connecting two arbitrary points on the earth's surface.

One of my criticisms related to inconsistencies between the times shown by different stations and the conclusions reached as to the direction and velocity of propagation. This can be better illustrated by some data used more recently by Dr. Bauer himself (*Terrestrial Magnetism*, December, 1910, Table IV., p. 225), which are much more open to criticism than those from the Coast and Geodetic stations. He takes seventeen disturbances given by Mr. Ellis as recorded at eight stations between 1882–9. Dr. Bauer forms two groups of these stations, the second containing Bombay, Batavia (107° E.), Zikawei (121° E.), and Melbourne (145° E.). Omitting hours, here are the times in minutes assigned for the commencements at the three last-mentioned stations :—

37·0, 39·7, 8·7, 48·7, 52·7, 42·7, 20·7, 44·0, 4·7, 48·7, 46·7,
18·7, 54·7, 32·7, 24·7, 45·7, 52·7,

31·3, 32·3, 0·3, 45·3, 46·0, 35·6, 21·3, 38·3, −1·2, 41·8, 41·0,
15·3, 50·3, 27·3, 20·8, 41·3, 47·4,

38·4, 33·4, 5·1, 50·0, 55·1, 45·1, 25·1, 45·1, 0·1, 55·1, 45·1,
15·1, 50·1, 35·1, 25·1, 45·1, 45·1,

The number of 7's in the first and second lines, of 3's in the third and fourth, and 1's in the fifth and sixth, tell a tale to anyone who has eyes. It is the treatment of the data, however, to which I would direct attention. Zikawei, though intermediate in longitude, differs usually in the same direction, as regards time of commencement, from Batavia and Melbourne. Its time is earlier than that of Batavia in sixteen cases, and than that of Melbourne in fourteen cases, out of seventeen; and the mean algebraic difference is no less than 5·2 *minutes* in the one instance and 4·6 in the other. Instead of recognising that data such as these are useless for any purposes of high accuracy, Dr. Bauer gets out means from his two central stations and obtains an average of between three and four minutes for the time of going completely round the earth, a time markedly less than the data employed give between Batavia and Zikawei, stations differing by less than 15° in longitude or 38° in latitude.

A final criticism I might mention is this: If disturbances travel round the earth in the way Dr. Bauer supposes, why do not they quite complete the circuit, or even go round several times? In some cases, at least, the amplitudes of commencing movements at stations nearly 180° apart are very similar, so that going half-way round can have had but little effect, and movements with a much reduced amplitude would still have been conspicuous. Earthquake tremors, we know, do go round more than once.

As regards the theory vaguely outlined by Dr. Bauer (pp. 10–11), I am not surprised by his claim that "the careful reader will not fail to observe that . . . [it] is considerably different from that which Dr. Chree imputed to me." But unless I had had prophetic powers, how could it have been otherwise? The earlier theory reached or was based on a definite mathematical equation (*Terrestrial Magnetism*, June, 1910, p. 123), $v = XneD/p$, where v is "the velocity of the moving ions . . . n the number of molecules in a c.c. of gas at a pressure p dynes per sq. cm., e the electric charge carried by an ion, D the coefficient of diffusion of an ion through the gas." Of X Dr. Bauer tells us :—"Regarding the variation of X, some preliminary calculations would appear to indicate that the potential gradient of 1 volt per cm. assumed may be of about the right order of magnitude for the heights concerned" (75 km. is the height finally suggested). My primary difficulties were two. Sir J. J. Thomson, the authority quoted by Dr. Bauer, applies the formula to ions moving in the direction of the field X. Dr. Bauer makes v a horizontal velocity; but "potential gradient" is a term usually applied to the earth's *vertical* field, and 100 volts per metre is the value usually ascribed to it, as an average (probably a low one), at ground-level. Potential gradient, in the usual sense of the term, is known from balloon observations to fall to one-tenth of its ground-level value at heights of a few thousand feet, and at 75 km. it is usually supposed to be infinitesimal. If by "potential gradient" Dr. Bauer means a horizontal field, he should say so explicitly, and explain how it is produced and how he reaches his numerical estimate. As regards his concluding remark on the question of theory, "If Dr. Chree has something better to offer I shall be glad to know it," I labour under the disadvantage of holding the view—antiquated though it may appear to some of my contemporaries—that before advancing a mathematical theory for any supposed phenomenon, it is desirable to make reasonably sure that the phenomenon actually exists.

If we take Dr. Bauer's latest conclusions respecting the fifteen storms he deals with in NATURE, we have nine going east and six west. The mean algebraic difference between the European and American times of commencement, + denoting earlier occurrence in America, is only +0·11 minute. In view of the fact mentioned by Dr. Bauer that the algebraic mean difference between the times deduced by two skilled observers, Drs. Venske and Krogness, for the commencements of six disturbances at Potsdam—one of the best equipped of stations—was no less than 0·4 minute, I think most physicists of experience will recognise the expediency of awaiting something much more decisive before passing a final judgment.

March 4. C. CHREE.

TOGETHER with Mr. O. Krogness, I am just on the way to Khartoum, in Sudan, in order to carry out some researches on the zodiacal light.

In connection with these investigations, we propose to secure some magnetic records with very sensitive apparatus. Special care will be taken to obtain as accurate a time-determination as possible.

For one set of observations we shall use an hour-length of 20 mm.; for another set, with twelve times greater hour-length, records will be obtained between about 5h. p.m. and 3h. a.m. Greenwich mean time.

If at other observatories, especially near the equator, similar *rapid* records could be secured *in the same time-interval*, these would, I think, be of value in deciding the question of the simultaneity or non-simultaneity of abruptly-beginning storms.

Our records are intended to commence on March 20, and will continue for one month.

Similar records will also be obtained by Prof. S. Saeland in Trondhjem. KR. BIRKELAND.

Berlin, March 3.

The Centenary of Bunsen's Birth.

ON March 31 it will be one hundred years since Robert William Bunsen was born, and it has been felt that that occasion should not be allowed to pass without his pupils and admirers in this country giving expression to their veneration of the memory of one of the greatest chemists of our times. A committee has been formed to make the necessary arrangements, and it was intended to celebrate the centenary by a dinner. Unfortunately, the two most distinguished pupils of Bunsen, Sir Henry Roscoe and Sir Edward Thorpe, are at present prevented by indisposition from attending such a celebration. In these circumstances the committee has decided not to proceed with the arrangements for a dinner; but, feeling that the occasion should not be allowed to pass unnoticed, they have resolved to send a signed address to the Heidelberg University from old Heidelberg students in this country, and to place a wreath on the Bunsen monument. May we request those old Heidelberg students who wish to participate in this movement to send their signatures to Prof. H. B. Dixon, of the Manchester University, the chairman of the committee, or to either of the undersigned honorary secretaries?

FRANCIS JONES (Manchester Grammar School).
J. GROSSMANN (Plymouth Grove, Manchester).

Chemical Laboratory, 157 Plymouth Grove,
Manchester, March 11.

Life and Habit.

YOUR correspondent "W. H. M." (NATURE, March 2, p. 12), who believes that it is necessary for newly hatched chicks to learn to eat by imitation, should see a litter of pigs being born. Each little pig the moment that he is outside hurries over the sow's hind legs, and, in the second second of his outdoor life, has a teat in his mouth. If the navel-cord has not got clear of his late home, he tugs away at it with all his might. Seeing such a sight, one might suppose that before birth the creature had been eagerly looking forward to his first breakfast. Or did the splendid prospect flash into his mind only as he found his feet? FRANCIS RAM.

54 St. John's Road, N., March 13.

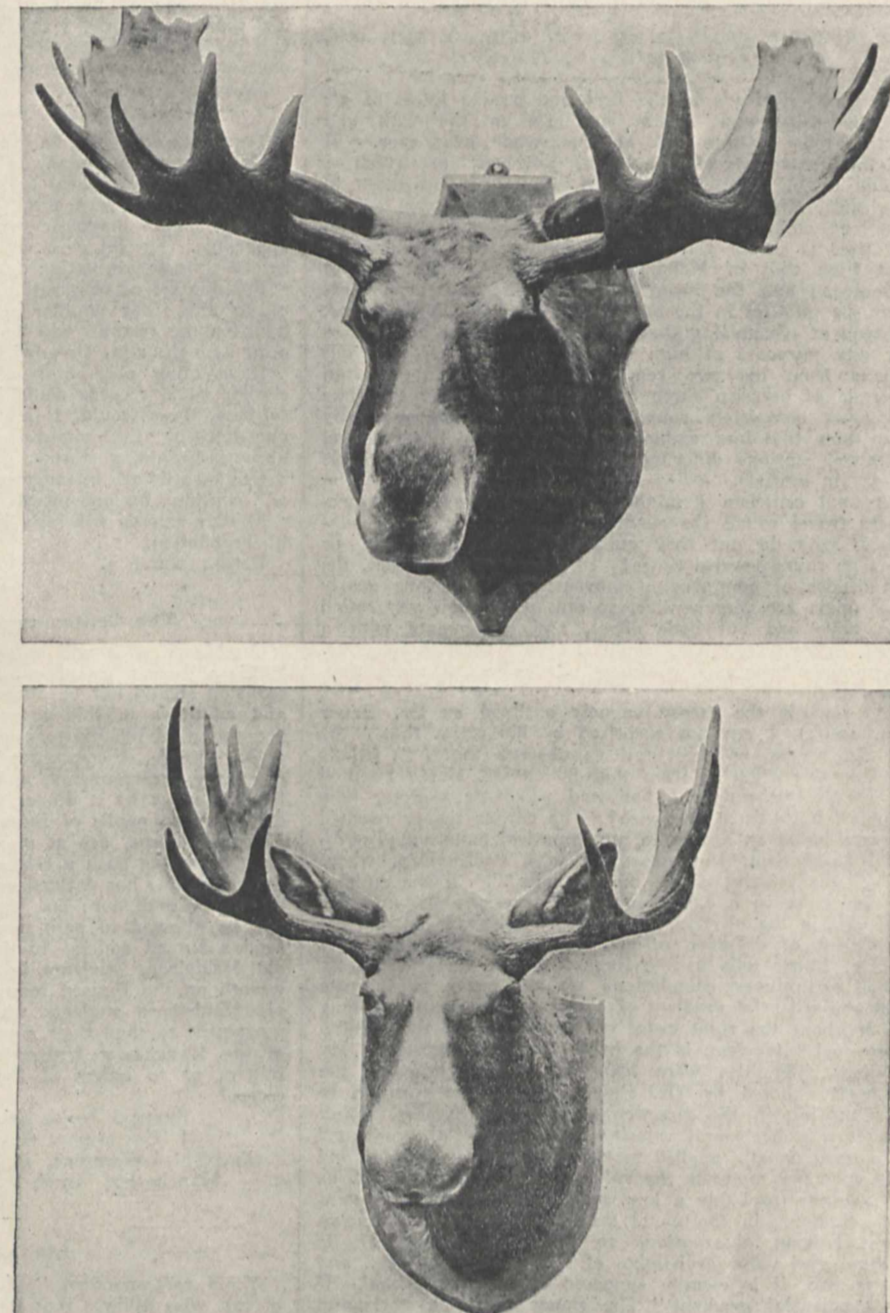
BIG-GAME SHOOTING IN PATAGONIA AND NEWFOUNDLAND.[1]

"IN Patagonia no one uses the word 'mile,' the distances are so great that all reckoning is counted in leagues," writes Mr. Prichard in his remarkably interesting studies of these desolate, extra-tropical pampas of South America. He contrasts this measurement with what prevails in vast Canada, where the land is so good and so usable that the distances are computed by the acre. "In sterile Patagonia, no farmer can make a living on less than fifteen square miles." In this region he pursued the wild guanaco, belonging, as he does still, to the old school, which thinks it better sport to kill than to photograph. He also shot the guemal, or Patagonian deer—*Cariacus* or *Mazama bisulca.* (The reviewer wishes that some zoologist of commanding physique and authority would settle, as with a hammer or an axe, what is to be the universally accepted generic name or names of this group of American deer.) We are probably still without adequate and correct information regarding the species and varieties of South American deer, and even the size to which some of them attain and the fullest developed type of antler. Mr. Prichard estimates that the Chilian (Patagonian) guemal stands from 36 to 38 inches at the shoulder and weighs about 160 lbs. He states that the specimens of horns in the British Museum are poor. The antlers given in the painted illustrations seem slightly more developed than those in the photographs of the specimens obtained by Mr. Prichard himself, though these are of distinct interest, and perhaps, as he says, much better than anything in the national collection.

The guemal, according to Mr. Prichard, does not range eastwards far from the foothills of the Andes; it is practically absent from the flat, grassy plains of Patagonia.

Besides this deer and the guanaco, Mr. Prichard shot rheas, swans, geese, ibis, condor, Magellan wolves, and saw several fine specimens of puma. He records how this "poor-spirited cat" is frequently tamed and kept as a pet until almost full-grown. One settler near Lake Argentine lived alone in a single-roomed hut throughout the winter with two three-quarter-grown pumas.

As to the Amerindian natives of this region, the Tehuelche, he describes them as a fine race, with large, well-hewn features, their skin of a reddish-brown. But although they average six feet in stature, they have notably deteriorated in physique, from their habit of riding on all occasions and everywhere. A man will not walk a hundred yards, but catches his



The Heads of Canadian and Norwegian Elk contrasted (the lower head is Scandinavian). From "Hunting Camps in Wood and Wilderness."

[1] "Hunting Camps in Wood and Wilderness." By H. Hesketh Prichard. With a Foreword by F. C. Selous. Pp. xiv+274. (London: W. Heinemann, 1910.) Price 10*s.* net.

horse and rides the distance. So far as the upper part of the body is concerned, the breadth of shoulder and great back and arm muscles demand admiration, but the lower limbs are not proportionately strong.

From the Andes and treeless plains of Patagonia Mr. Prichard whisks the reader to the wildest parts of Labrador and of Newfoundland. After that we have a digression dealing with moose (elk) hunting in Norway, distinctly interesting by the juxtaposition of the scenery, flora and fauna of that country with the north-eastern parts of British North America. Mr. Prichard attempts to show by his illustrations and explanations—or leads us to infer—that a specific difference exists between the elk of northern Europe and the elk of North America, which is cited as *Alces americanus*. But we fancy that zoologists do not claim a full specific difference between these creatures, widely as their habitats are separated at the present day. If the reviewer's memory is correct, Mr. Lydekker himself only claims for the very marked variety of elk in north-eastern Asia the position of a subspecies, *Alces machlis bedfordiae*; and there is distinctly less difference in antlers and other features between the elk of North America and that of Scandinavia, except that no doubt during the last hundred years or so the antlers of the last-named have degenerated, owing to the persecution of the species at the hands of the hunters. Nevertheless, the present difference in size between the Canadian and Norwegian elks is well illustrated by the photographs here reproduced.

Very interesting, and in some respects novel, information is given about the Canadian elk. Mr. Prichard, quoting other authors, touches on the discovery of the gigantic subspecies of elk in that country of marvels, Alaska, the home of the biggest existing bear, the biggest wild dog or wolf (*Canis pambasileus*), and of the biggest elk (*A. m. gigas*), a monster with palmated antlers measuring 76 inches in contradistinction to the 40 inches of an exceptionally good head in Norway, and the average 50 inches of Canada.

Some splendid heads of caribou (Canadian reindeer) were secured by Mr. Prichard and his companion, Mr. Gathorne Hardy. Admirable photographic illustrations are supplied to illustrate the scenery of Newfoundland, a country still all too little known to adventurous travellers seeking for varied phases of landscape beauty. We are made to realise the desolateness of Labrador and yet the charms of its solitude.

"A little lake . . . lay some two miles to the north-west of our camp. Surrounded by trees and seemingly of great depth, it presented the appearance of an unfathomable pit sunk into the roots of the hills. The diver and her brood called ceaselessly upon its waters, bringing back to memory the beautiful and poetic words of Saltatha, the Yellowknife Indian: 'You say the Kingdom of Heaven is good, my father, but tell me, is it better than the land of the musk-ox in summer, when the lakes are sometimes misty and sometimes blue, and the loons cry often? That is good, my father, and if Heaven is better, I shall be willing to dwell there until I am very, very old.' Besides the loon two ospreys haunted the lake, sometimes fishing in the shallow stream which fed it, sometimes winging their way over it and out into the blue distance towards the sea."

Elsewhere in the book there are pen portraits, unconsciously given, of the different guides, hunters, and trackers associated with Mr. Prichard or his companions, some of Newfoundland, some of Labrador, and one or two of Maine (United States) origin. In every case, these simple, virile, honest natures are brought home to us with their quaint diction, shrewd faces, and slovenly clothing, and we realise what good stuff there must be in the manhood of North America. The Mikmak Indians of Newfoundland (recent comers and settlers from the adjoining coasts of Cape Breton and Nova Scotia) are also illustrated verbally and by photography. Mr. Prichard justly points out that it is sentimental nonsense allowing Indians greater privileges in the way of game destruction than are accorded to white men. All alike are citizens of British North America, enjoying the same privileges and subject to the same laws, and it would be no satisfaction to the zoologists of the next generation to be told that the big game was destroyed in Newfoundland by Indians and not by white men.

Altogether this is one of the most attractive and informative works on the big game of the New World which the present reviewer has had the pleasure of reading. The coloured illustrations by Mr. E. G. Caldwell are of remarkable excellence, worthy of Mr. J. G. Millais. Besides being beautiful pictures, they are absolutely truthful, not only in the delineation of beasts, but in the botany of the background. Two of Lady Helen Graham's drawings also deserve special mention; one, of a scene in the Patagonian Andes with guemal deer in the foreground, and another, a study of a bull elk being surprised at night by the light of a lantern.

H. H. JOHNSTON.

THE FANCY FEATHER TRADE.[1]

IN NATURE for December 15, 1910, we reviewed "Aigrettes and Bird-skins," a book written in defence of the bird-plume dealers, in which the name of Mr. C. F. Downham was cited frequently as a witness for the "defendants." This gentleman now appears before us as further counsel on the same side in an address under the second title of "Some Facts and Fallacies in Connection with the Trade in Fancy Feathers," delivered before the London Chamber of Commerce in November last. Part of it has been published as an article in the *National Review*; "The Feather Trade: The Case for the Defence," is an amplified edition. In the number of NATURE just referred to—which may be read in connection with the present observations—we strongly expressed our disagreement with the arguments then put forward. Our view we find independently supported by the *Madras Mail* of September last, which says that "'Aigrettes and Bird-skins' will evoke little sympathy in India. Indeed, it would more probably be read with feelings of derision and ridicule on account of its erroneous and fallacious arguments were its subject not so pathetic."

These words seem to us to sum up very tersely the further defence made by Mr. Downham, who, as managing director of one of the plume-importing firms, can hardly be considered an entirely disinterested advocate. In years past the defence set up by the trade was that the "aigrettes" were artificial, and all the plumassiers' saleswomen were directed to inform tender-hearted buyers that this was really so. Ornithologists were able, however, to nail this deception to the counter so effectually that it had to be abandoned. In its stead arises now the equally spurious statements that they are taken out of the nests, where they form a bed for the eggs; and that in vast heronries in S. America, in Venezeula in particular—whence the largest export comes—

[1] "Some Facts and Fallacies in Connection with the Trade in Fancy Feathers." A Paper read at the London Chamber of Commerce in November, 1910, by C. F. Downham. Pp. 126. (London Chamber of Commerce, Oxford Court, Cannon Street.) Price 6*d*. net.
"The Pros and Cons of the Plumage Bill." A Letter. By James Buckland, of the Royal Colonial Institute.

egrets and other birds are being protected, and that thence, "as for many years it has been known in the trade, a great part of the supply is obtained by collecting the feathers naturally shed by the birds . . . the *opinion* [the italics are the reviewer's] of those in the trade is that considerably more than two-thirds of the supply is so obtained."

These statements are attested by three witnesses: M. F. Geay (now dead); M. Leon Laglaize, who, in being, as it appears, a buyer for a firm of dealers, is scarcely as unprejudiced a witness as might be desired; and M. Grisol. Against their testimony must be set that sent to the Royal Society for the Protection of Birds by H.M. Minister at Caracas (dated January, 1909), who emphatically asserts that M. Laglaize "gives a completely erroneous impression of the conditions under which the industry of collecting plumes is conducted in Venezuela"; of the Consul at Rosario, and of various scientific men, among them, Mr. Quelch (a well-known naturalist, formerly on the staff of the British Museum), who describes the hideously cruel manner of taking the plumes, and declares that "during a residence of seventeen years in British Guiana . . . I have never known or heard of any such method of collection as that described by M. Laglaize"; of Mr. Dresser, author of "The Birds of Europe"; and of Mr. F. Chapman, the distinguished ornithologist of the American Museum of Natural History in New York. These witnesses are convinced that the "moulted plume" theory is as fallacious as the "artificial aigrette" defence, and ornithologists know that egrets do not line their nests with their own nuptial plumes.

It is significant that the collectors' busy time in the swamps is the height of the breeding season. The egrets assume their nuptial plumes before that period begins in August, and shed them only about October, till when there can be few—if any—plumes on the ground to gather. It is well known also that by that date the "aigrettes" have, by reason of wear and tear, become of little or no commercial value.

We find it stated by Mr. Downham that the fancy feather trade has its mainstay in poulterers' refuse and plumes of game birds killed for food; and then by the traders' own testimony, Are not the "aigrettes" wholly artificial? Why all this great outcry that their entire business is in peril should an Act be passed against the import of our finer plumaged bird-skins? The true egret imports can consequently have only a negligible influence on their market. It has been obvious to everyone that during the past year feathers have been worn in women's hats in greater profusion than ever, and that few of them have been those of game or barn-door fowls. Lyre-bird, Argus and Himalayan pheasant, flamingo, peacock, robin, jay, kingfisher, goldfinch, trogon, bird of paradise, and goura pigeon have come under the writer's own notice. Some hats, indeed, were entirely composed of British bird-skins. From Venezeula alone in 1908, 255,900 egrets were exported, and necessarily a large proportion of the offspring of these birds was sacrificed.

Mr. Downham's pamphlet contains short notes on the best-known species of paradise birds by Mr. A. E. Pratt, about which we may be allowed a word from an ornithologist's point of view. It would be interesting to have the evidence—no doubt in his possession—for the statements he makes that these birds are three years old before they produce marketable plumes, and that the Aru islanders watch over the *Paradisea apoda* until they have attained that age. We should hesitate to accept as a fact, without very strong evidence, that the Papuan will stay his hand against any living creature he wants when his opportunity occurs, in hope of some other day meeting it in better condition, and with the chance that his neighbour will forestall him. The fact that the collections of birds by native hunters contain mature and immature skins in equal abundance militates strongly against such a belief.

Our observations upon the Fancy Feather trade were already written before the Pros and Cons of the Plumage Bill reached our hands. All who are doubtful as to their support of this Bill should read Mr. James Buckland's pamphlet. The cruelty of the plumage collector's methods and the enormity of their slaughterings as here set out will appal the reader. He substantiates with exact chapter and verse the precise manner in which the Indian Plumage Bill is systematically evaded by the native plume collectors, because the import of feathers into London is so free and unprohibited. Mr. Downham, in his Case for the Defence, attempted to impune Mr. Buckland's statement made in 1909 that 1,500,000 egrets had been slaughtered in 1908 in Venezuela alone, by asserting that the customs export returns at Ciudad Bolivar were untrustworthy on the point. The British Minister, however, corroborates fully Mr. Buckland, and cuts from beneath them one more of the doubtful testimony of the plume traders, by stating in his report for that year:—"This [the destruction of egrets] is really appalling. . . . If, therefore, we take the average, the number of birds killed last year was 1,538,738; but if we take the highest number it was 2,469,930, and even the lowest accounts for the slaughter of 610,385." Mr. Downham also denies that egret feathers come from Australia. If this be so *now*, it must be because the heronries have been shot out. Mr. Buckland is able to adduce an eye-witness in Mr. Mattingley, the Australian ornithologist, to the methods practised by the Commonwealth gunners, in every respect similar in cruelty and ruthlessness to those of their brethren in Venezuela and elsewhere. Above we have thrown doubt upon the statements of Mr. Laglaize, adduced by Mr. Downham, as to the protection of the heronries in Venezuela and to the collecting of the plumes from the nests. Mr. Buckland goes so far as to assert that, "For sheer power and majesty of lying these statements excel anything ever achieved by Ananias, even at his best."

Mr. Buckland gives equally appalling details as to the destruction of gulls, terns, herons, grebes, pelicans, swans, geese, ducks, ibises, birds of paradise, goura pigeons, and humming-birds, in every region of the globe. "Great heaps, waist high, of dead *Diomedea immutabilis*, and of the black-footed albatross"; "On Marcus Island a party had wiped out of existence one of the largest albatross colonies in the Pacific," are a couple of extracts from him as to the operations of those who labour for the adornment of English ladies. Mr. Buckland's pamphlet supports also our doubt, expressed above, as to the Papuan hesitating to spare any bird he comes across, because it is immature.

It is abundantly evident, therefore, that the testimony, sworn statements, and various excuses brought forward in their attempts to represent this nefarious trade as a pure and legitimate industry, by the textile trade section of the London Chamber of Commerce, are sadly wanting, both in cogency and in veracity.

These latest attempts will, we trust, fail, like the others they have set up, to delay the Plumage Bill, introduced in the House of Commons on February 22, from becoming law "at the earliest possible opportunity," as *The Times* of November 26, 1910, so strongly urges, "which can be found in the new Parliament for business of an uncontentious character."

THE BLACKFEET OF MONTANA.[1]

THE Piegan Blackfeet of Montana are one of the most interesting of the tribes classed as Plains Indians, and it was well worth the while of Mr. Walter McClintock to spend many summers in living among them in order to study and record their customs and religion. The worthiness of his intention and his personal character so appealed to Mad Wolf—one of the prominent men of the tribe—that he adopted Mr. McClintock as his son, hoping for an alliance with a white man that would be productive of sympathy, and fidelity to the welfare of his tribe, and who, by being familiar with their customs, religion, and manner of life, would tell the truth about them to the white race. The present book is a justification of Mad Wolf's action.

FIG. 1.—A Woman Praying to the Sun. From "The Old North Trail."

Mr. McClintock has not written a formal treatise on the Blackfeet, and much that students would like to learn about them has been omitted. A book that would satisfy specialists would not appeal to the public, and doubtless the object of Mad Wolf will be better attained by the narrative form in which the book is cast. The descriptions of climate and scenery, of hunting experiences, and the daily life of an Indian camp give a live and accurate impression, not only of the present condition of the Indians, but enable the reader to gain some idea of what that life was like in the past, when immense herds of antelope and bison roamed over the plains and when the Blackfeet warriors traversed wide tracts of country in quest of plunder and adventure. The old men remember the days of their pride, but soon the memory of them will pass away and meagre records will alone be available in the books of such writers as Catlin, Mackenzie, Grinnell, and McClintock.

Several ceremonies are described, that of the "Beaver Medicine" being illustrated with numerous photographs showing various phases of the ceremony; as these were taken under adverse circumstances in a tipi, they are not so clear as the majority of the illustrations. Most readers will probably be astonished at the number of prayers that are said at these ceremonies, and Mr. McClintock deserves our thanks for having recorded so many of the prayers and chants. It is mainly by having the actual words that we can get a true insight into a ceremony, but, in addition, it is necessary to have a ceremony recorded by a sympathetic observer like the author, for it is quite possible to record every action and yet miss the spirit of a ceremony, as has too frequently been the case. Even at the present day the older Indians are extremely devout and spiritually-minded; this religious attitude of mind combined with a sense of dignity and personal worth are perhaps the most prominent characteristics of the Indian. The present writer has seen a Pawnee and a Blackfeet sacred bundle opened, and he quite endorses Mr. McClintock's statement that "It is difficult for one of the white race to realise the deep solemnity with which the Indians opened the sacred bundle. To them it was a moment of deepest reverence and religious feeling."

The Blackfeet are firm believers in the supernatural and in the control of human affairs by both good and evil powers in the invisible world. The great spirit, or great mystery, or good power, is everywhere and in everything—mountains, plains, winds, waters, trees, and animals. They believe that all animals receive their endowment of power from the sun, differing in degree, but the same in kind as that received by man and all things animate and inanimate. Some, such as the grizzly bear, bison, beaver, wolf, eagle, and raven, are worshipped because they possess a larger amount of the good power than the others, and so, when a Blackfoot is in trouble or peril, he naturally prays to them for assistance. The sun, as the great centre of power and the upholder of all things, was the Blackfeet's supreme object of worship. He saw that every bud, leaf, and blossom turned its face to the sun, that the berries ripened under its warmth, that men and animals thrived under its sustaining

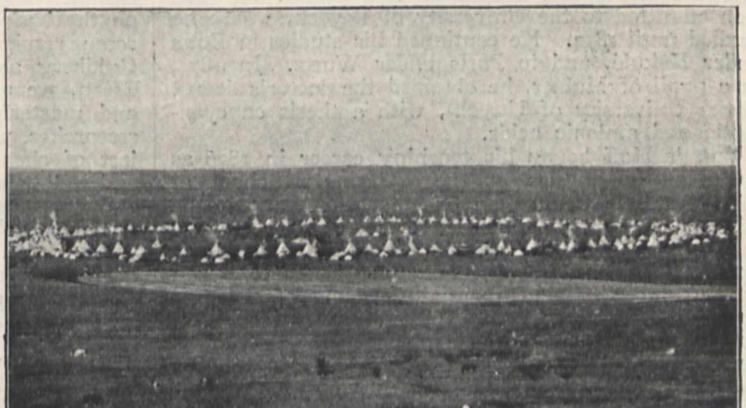


FIG. 2.—Tribal Camp of the Blackfeet. From "The Old North Trail."

[1] "The Old North Trail," or Life, Legends, and Religion of the Blackfeet Indians. By W. McClintock. Pp. xxvi+539. (London: Macmillan and Co., Ltd., 1910.) Price 15s. net.

light, but all perished when it was withdrawn. The devout Blackfoot therefore called upon men, women, and children, and everything that had breath to worship the all-glorious, all-powerful sun-god who fills the heaven with brightness and the earth with life and beauty. The sun-dance was their great annual religious festival, their holy sacrament, the supreme expression of their religion. It must always have its beginning in a woman's vow, made to the sun-god for the recovery of the sick. The account given of the sun-dance is of interest, but far too short for the student.

Various legends and stories are given, and the occasions on which they were told are given, so the tales fit naturally into the pictures of Indian life that Mr. McClintock presents. This is a book that should be read by all who are interested in the ways and thoughts of alien folk, and its value is increased by the very numerous and excellent photographs taken by the author. A. C. HADDON.

PROF. J. H. VAN 'T HOFF.

IT is with the deepest regret that we record the death of Prof. J. H. van 't Hoff, which occurred on March 1, at Steglitz, near Berlin. It was known that his health has not been good for the last two or three years, but the unexpected news of his death at the comparatively early age of fifty-eight years will come as a very heavy blow to the world of science. For a generation the name of van 't Hoff has been familiar to students of science in every part of the civilised world. It would be difficult indeed to mention any branch of modern scientific inquiry which has not been advanced by his fundamental discoveries. Certainly physiology, biology, and geology, as well as every branch of chemistry, owe a deep and undying debt of gratitude to the genius of van 't Hoff. The memory of his name and the influence of his work will outlive the centuries, an integral part of the incorruptible heritage of science.

Jacobus Henricus van 't Hoff was born in Rotterdam on August 30, 1852, his father being a physician of that city. In 1869 he proceeded to the Polytechnikum at Delft, passing through the usual three years' technological course in two years. He was then admitted to the University of Leyden, where he studied until 1872. He continued his studies in Bonn under Kekulé, and in Paris under Wurtz. In 1874, as a pupil of Mulder, he obtained the doctor's degree of the University of Utrecht, with a thesis on cyanacetic and malonic acids.

Van 't Hoff began his teaching career in 1876 as a docent in physics at the Veterinary School at Utrecht. In 1877 he went to Amsterdam, and in the following year was appointed professor of chemistry at the University of Amsterdam. Here he remained for eighteen years.. In 1896 he was called to Berlin as a member of the Imperial Academy of Sciences and as a professor of the University of Berlin. He gave lectures on physical chemistry at the university, but a research laboratory was provided for him by the Academy of Sciences. In this position van 't Hoff continued to work until his death.

Such is a very brief account of the various positions he held during his lifetime. Needless to say, universities, scientific societies, and academies throughout the world vied with each other in honouring him. In 1888 he was elected a foreign member of the Chemical Society of London. He became a foreign member of the Royal Society in 1897, whilst the Physical Society of London elected him a foreign member this year. Amongst others, the universities of Cambridge, Chicago, Heidelberg, Manchester, Greifswald, and Utrecht conferred honorary degrees upon him. The Kaiser bestowed on him the high distinction of the Order "Pour le Mérite." In 1901 the Nobel Prize was awarded to him. Many other honours and distinctions might be mentioned, but enough has been said to show the high esteem in which van 't Hoff was held throughout the world. Like all great men of science, the true story of his life is, however, to be found in his researches.

Under the influence of Kekulé, Wurtz, and Mulder, the earliest work of van 't Hoff relates to organic chemistry. But here his genius soon enabled him to strike a note of extraordinary originality. While still engaged with Mulder in synthetic organic work, he published in 1874 a short pamphlet in Dutch, in which he unfolded his new ideas concerning the extension of organic structural formulæ to three-dimensional space, and the relation between optical activity and the presence of an "asymmetric" carbon atom. In 1875 this appeared in an enlarged form under the title "La Chimie dans l'espace," a German edition, with a preface by J. Wislicenus, appearing in 1877 ("Die Lagerung der Atome im Raume"). Thus was born van 't Hoff's famous theory of the "tetrahedral" carbon atom and the science of stereochemistry. As all the world now knows, van 't Hoff's new ideas found many opponents. In particular Kolbe, who was an opponent of structural chemical formulæ in general, attacked the new ideas and their author with great virulence. But the "lame Pegasus" which the young lecturer at the Utrecht Veterinary School had bestridden was not so lame as Kolbe imagined, and van 't Hoff's ideas gradually triumphed. The warm support of Johann Wislicenus and the work of himself and his school greatly contributed towards the recognition and development of van 't Hoff's ideas.

Not long after the appearance of the "Chimie dans l'espace," van 't Hoff published a very remarkable and little-known book, entitled "Ansichten über die organische Chemie." In it he sought to give the whole of organic chemistry a strict and logical arrangement, wherein both old and new facts should find their proper place. At the same time he emphasised the necessity for a *quantitative* study of the course of chemical reactions, and developed the fundamental equations of chemical kinetics and equilibrium on the basis of the law of man-action. Although in some respects van 't Hoff was preceded here by Guldberg and Waage, as well as by Harcourt and Esson, we perceive here the beginning of that long and masterly series of experimental and theoretical researches, whereby van 't Hoff raised the whole subject of chemical dynamics to the level of an exact and well-ordered branch of science. In the celebrated and now classical "Etudes de Dynamique chimique" (1884), van 't Hoff gave a collected account of these researches. Here is to be found a systematic study of the velocity of reactions, *as dependent on the number of reacting molecules*, a method for determining the number of reacting molecules from the experimental data, an exhaustive study of the "disturbing" actions, and an investigation of the influence of temperature on velocity of reaction. Masterly as was the treatment of chemical kinetics here set forth by van 't Hoff, one would err grievously in imagining the "Etudes" to contain nothing else. Nearly one-half of the monograph was devoted to chemical equilibrium and affinity. In this portion van 't Hoff abandoned the purely molecular-kinetic standpoint, treating the subject from the point of view of thermodynamics. One finds here the classical treatment of the equilibrium of "condensed" phases, and of the influence of temperature and pressure thereon. Here is also to be found the enunciation of van 't Hoff's famous "Principle of Mobile Equilibrium":—"Tout équilibre entre deux états différents de la matière (systèmes) se déplace par un abaissement de la température du côté de celui des deux systèmes, dont la formation développe de la chaleur."

Finally, in the chapter on affinity, perhaps the most remarkable and original part of the whole book, van 't Hoff shows for the first time how the chemical forces operative in reaction can be measured and compared.

But van 't Hoff's greatest triumph was still to come, though we may regard the application of thermodynamics to chemical equilibrium to be found in the "Études" as preparing the way for it. In 1886 van 't Hoff's famous paper on "The Laws of Chemical Equilibrium in the Dilute, Gaseous or Dissolved State of Matter" was published in the Transactions of the Swedish Academy of Sciences. This was quickly followed by two other fundamental papers, one on "A General Property of Dilute Matter," and one on "Electrical Conditions of Chemical Equilibrium." In 1887 there appeared in the first volume of the "Zeitschrift für physikalische Chemie" an abstract of the above, bearing the title "Die Rolle des osmotischen Draches in der Analogie zwischen Lösungen und Gasen."

It would be impossible to exaggerate the fundamental importance of these researches. By developing the idea of osmotic pressure on the basis of the experimental work of Traube and Pfeffer and by an application of the laws of thermodynamics, van 't Hoff was enabled to put the whole subject of physical and chemical equilibrium in dilute solutions on a sure and simple basis. The extraordinary analogy which he discovered, and showed also to be thermodynamically necessary, between the laws connecting the osmotic pressure, molecular concentration, and temperature of a dilute solution and the corresponding simple gas laws, played a profound part in this development.

Although the laws of equilibrium in solutions had been given by Gibbs previously in a generalised thermodynamical form, and had been applied by Helmholtz to cases where the partial vapour-pressures as functions of the concentration were empirically known, van 't Hoff was the first, by means of the concept of osmotic pressure and the simple laws relating to it, to create a practically useful thermodynamical theory of dilute solutions. In doing this he demonstrated the insufficiency of Guldberg and Waage's laws in its original form, and paved the way for the electrolytic dissociation theory of Arrhenius and its development and application by Ostwald and Nernst. In fact, the simple interpretation which the theory of electrolytic dissociation gives to the coefficient *i* of van 't Hoff's thermodynamical equations remains to-day, as it was twenty years ago, one of the chief foundations of this theory.

The theory of dilute solutions, as developed by van 't Hoff, rendered inestimable service to the general development of chemical science in the sure thermodynamical basis which it gave to the previously empirical methods for determining the molecular weights of dissolved substances. It would be difficult indeed at the present day to discover any branch of chemical, physiological, or biological science which does not owe something to the fundamental advances made by van 't Hoff in the theory of physical and chemical equilibrium in dilute solutions.

The last great period of van 't Hoff's scientific activity was mainly devoted to a study of heterogeneous equilibrium, especially as regards the conditions determining the formation and decomposition of double salts, and the crystallisation of complex mixtures. The first fruits of these researches appeared in collected form in his "Vorlesungen über Bildung und Spaltung von Doppelsalzen" (Berlin, 1897). Here for the first time were set forth in lucid and masterly manner all the conditions of temperature and concentration which determine the crystallisation of double and single salts, with many and varied applications to special cases, culminating in the unravelling of the complicated phenomena presented by the double racemates of Scacchi and Wyrouboff. Another striking case was the working out of the conditions of formation of Schönite. The book also contains an account of the beautiful experimental methods worked out by van 't Hoff for the determination of transition-points.

The researches summarised in this book may be regarded as forming a fitting prelude to the great work which van 't Hoff undertook during his residence in Berlin, namely, the investigation of the formation of oceanic salt deposits, with special reference to those occurring at Stassfurth. This great geological problem was undertaken in collaboration with Meyerhoffer, and with the help of a number of research students. It reduced itself practically to the determination of the heterogeneous equilibria occurring in solutions containing the chlorides, sulphates, and borates of sodium, potassium, calcium, and magnesium. Proceeding step by step from the simple to the more complex solutions, and employing all the methods which he had previously worked out for determining equilibria and transition-points, van 't Hoff slowly but surely succeeded in unravelling the gigantic problem which he had set himself to solve. It would be quite impossible here to convey even a faint idea of the complexity of the task, and of the genius which enabled van 't Hoff to attack it so successfully. Probably no part of his life-work is less generally known than the wonderful series of researches which issued from his laboratory at Charlottenburg during the years 1896–1909, and yet it may be safely said that these researches constitute an absolutely fundamental advance not only in physical and inorganic chemistry, but also in scientific mineral synthesis and rational *experimental* geology. They will for ever remain the classical model for the application of the methods and principles of heterogeneous chemical equilibrium to the science of experimental mineralogy. Van 't Hoff published a collected account of these researches in two small volumes with the modest title, "Zur Bildung der ozeanischen Salzablagerungen" (Vieweg, Brunswick, 1905 and 1909.) This magnificent work on the Stassfurth salt deposits was the last great problem to which van 't Hoff devoted his attention. It forms a fitting close to a life of strenuous work and extraordinary scientific fertility.

In spite of the continuous labour involved in his daily work in the laboratory and in the publication of his researches, van 't Hoff found time, during his residence in Berlin, to publish his "Vorlesungen über theoretische und physikalische Chemie" (Vieweg, Braunschweig). This will long remain a standard work on theoretical chemistry. It is characterised by great originality of treatment, remarkable breadth of outlook, and that close and intimate relationship of fact and theory which was always one of van 't Hoff's salient characteristics.

Of other works may be mentioned a short summary of the "Theory of Solutions," published in Ahrens' "Sammlung chemischer Vorträge" (1900), and the delightful "Acht Vorträge über physikalische Chemie" (Vieweg, 1902), an embodiment of the lectures which van 't Hoff was invited to give at the University of Chicago in 1901 on the occasion of the decennial celebrations of the foundation of that university.

Since its foundation, in 1887, van 't Hoff's name has been associated with the "Zeitschrift für physikalische Chemie" as one of its editors. In 1899 the thirty-first volume of that journal was devoted to a "Festschrift" in honour of the twenty-fifth anniversary of his doctorate, many of his old pupils and many other men of science contributing papers in honour of the occasion.

The above is but a brief and meagre account of the life-work of one of the greatest geniuses the world has ever seen. It would take many pages of this journal to convey anything like an adequate idea of the extent and originality of his researches. But the only true appraisement of van 't Hoff's work and influence is to be found in the living science of to-day and in the minds of countless thousands of scientific workers. As time rolls on his name and his work will stand out ever more prominently in the story of the development of chemical theory. We are still too near the mountain to be able to appreciate fully the grandeur of its heights.

The present writer is one of those whose privilege it is to have worked under van 't Hoff. That was in the days at Charlottenburg, when the investigation of the oceanic salt deposits was just beginning. Every day endeared van 't Hoff to the small band of workers in his laboratory. His joy in his work, the simple and unaffected friendliness of his nature, and the marvellous power of his mind affected us most deeply. All who worked with van 't Hoff quickly learned to love and respect him, and we were no exception to the rule. The kindliness of his heart and the simple charm of his manner were no less characteristic of him than the genius that is known to all.

With the passing away of van 't Hoff chemistry loses one of her greatest men. His was indeed one of the master-minds of science. All his work was characterised by the penetrating insight and the wide creative outlook of a lofty and commanding genius. When one reflects on the vast regions of knowledge which he either created or systematised and marvellously developed—stereochemistry, chemical dynamics, chemical equilibrium and affinity, the laws of solutions—the thought occurs to one that future ages will see in him the Newton of chemistry.

However that may be, chemical science, which to-day so deeply mourns his loss, will ever rank van 't Hoff amongst the greatest chemists of any age.

F. G. D.

NOTES.

THE death of the able and accomplished naturalist Prof. Félix Plateau occurred at Ghent on March 4 after a long and painful illness. Prof. Plateau only recently retired from the active duties of his chair of zoology in the University of Ghent, and was appointed *Professeur émerite*. From his earliest days he pursued the study of his favourite science with indefatigable energy, devoting himself, in the main, to the arthropods, and especially to the Insecta and their physiological and physico-chemical aspects. Though of slight build and apparent delicacy, yet he was enabled, since he visited the British Association in Liverpool in 1870, to carry out a long series of researches for more than forty years, enriching the literature of his subject in a noteworthy way with both pen and pencil. His labours embraced such subjects as the vision of arthropods (including insects), respiratory movements of insects, centre of gravity in insects, functions of antennæ, physico-chemical observations on aquatic insects, movements and innervation of the central organs of the circulation in insects, errors committed by Hymenoptera in visiting flowers, means of protection in Abraxas, observations as to whether the syrphides admire colours of flowers, and a large number of researches on the behaviour of insects with regard to flowers, natural and artificial, besides numerous papers on allied subjects. These memoirs were illustrated by his facile pencil, and were carried out with great labour and ingenuity by means of apparatus devised by himself. Prof. Plateau was a member of the Royal Academy of Sciences of Belgium, and was much esteemed for his amiability and wide culture. He will be greatly missed as an earnest and indefatigable investigator of that side of entomology from which modern science has been enabled to draw safe deductions instead of vague suppositions. He leaves a widow and several sons and daughters.

IT is difficult to believe that Viscount Dalrymple was serious in asking the First Lord of the Admiralty in the House of Commons on March 8 "whether he would arrange for the fleet to carry out their heavy gun-firing practice round the coast at some other period of the year than in the middle of harvest time, when the resulting heavy rain may cause serious loss to the farming community." Mr. McKenna answered the question evidently in the belief that it was asked in good faith; he began by saying "there is no evidence that the firing causes heavy rain," and we do not need to concern ourselves with the rest of the reply. No doubt, whether Lord Dalrymple was jesting or not, many people still cling to the belief in the power of explosions to produce rain, and we referred last week to several cases in point. In the new number of *Symons's Meteorological Magazine* Mr. F. Gaster points out that the firing of big guns is carried on more frequently at Shoeburyness than at any other point on the coast, but that the mean annual rainfall at Shoeburyness, and on the coast of Essex generally, is the lowest in the British Isles. This seems to be the most convincing form of reply to those who profess to believe, or do believe, in the efficacy of gun-firing to produce rain.

LORD CRAWFORD presided at the meeting on March 8, at the British Museum, to present Sir Edward Maunde Thompson, late director and principal librarian, with his portrait, painted by the president of the Royal Academy (Sir Edward Poynter), who is also a trustee of the museum. Among the subscribers were the Archbishop of Canterbury (appointed a trustee in 1884 by Queen Victoria), who made the presentation, the Speaker, Sir Henry Howorth, Lady (John) Evans, and the officers and assistants of the museum, including Mr. F. G. Kenyon (director and principal librarian), Mr. L. Fletcher, F.R.S. (director of the natural history departments), Mr. A. R. Dryhurst and Mr. C. E. Fagan (assistant secretaries), Mr. Basil H. Soulsby, and many others. The portrait will be exhibited at the Royal Academy, and may one day join the collection of portraits of principal librarians and trustees in the board-room at the British Museum, which includes the portrait of Sir Antonio Panizzi by G. F. Watts, and Sir Joseph Banks by Lawrence.

DR. ÖSTEN BERGSTRAND, for some time observer at the Upsala Observatory, Sweden, has been appointed professor of astronomy in the Upsala University and director of the observatory.

THE Belgian Maritime Association has engaged M. H. Phillipot, assistant in charge of the meridian service at the Uccle Observatory, as professor of astronomy on board the Belgian naval college ship *L'Avenir*. The engagement is for six months, and the ship left Sunderland for Montevideo on March 9.

THE next triennial prize of 300*l.*, under the will of the late Sir Astley P. Cooper, will be awarded to the author of the best essay or treatise on "The Means by which the Coagulability of the Blood may be Altered." Essays, written in English, must be sent to Guy's Hospital, addressed to the physicians and surgeons, on or before January 1, 1913.

THE annual congress of French geographical societies is to be held this year at Roubaix, during the exhibition in that town, from July 29 to August 5, under the presidency of Prince Roland Bonaparte.

AT the recent meeting of the Australasian Association for the Advancement of Science in Sydney, the Mueller memorial medal was awarded to Mr. Robert Etheridge, curator of the Australian Museum, in recognition of the value of his numerous contributions to the palæontology and ethnology of Australasia.

A REUTER message from Portici states that on March 12 a portion of the crust around the crater of Vesuvius, 300 metres long and 24 metres in thickness, suddenly subsided, causing an appreciable shock of earthquake. Small portions of the crust continue to fall in, and a canopy of ashes is hanging over the mountain. As the result of the collapse the crater seems to be lower, and Vesuvius bears the appearance of having been decapitated.

WE learn from the Vienna correspondent of *The Times* that on March 9 the Austrian Academy of Sciences held a special sitting to celebrate the fiftieth anniversary of the appointment of the Archduke Rainer to be its curator. The Archduke marked the occasion by giving a sum amounting to about 4166*l.* to the academy as an endowment for those members who may need to keep in touch with the progress of their special branches of study in other countries.

ON Tuesday next, March 21, Dr. M. Aurel Stein will deliver the first of a course of three lectures at the Royal Institution on "Explorations of Ancient Desert Sites in Central Asia." The Friday evening discourse on March 24 will be delivered by Sir David Gill on "The Sidereal Universe," on March 31 by Prof. H. S. Hele-Shaw on "Travelling at High Speeds on the Surface of the Earth and above It," and on April 7 by Sir J. J. Thomson on "A New Method of Chemical Analysis."

PROF. VLAD. KULCZYŃSKI, the distinguished arachnologist, of Cracow University, is just concluding the thirtieth year of his scientific activity. The physiographical committee of the Cracow Academy of Sciences intends to commemorate this anniversary by presenting to him an album with photographs of his fellow-zoologists and friends, who are invited to send their photographs, together with at least 20 kronen (=17*s.*), to Prof. E. Godlewski, Cracow University. The surplus of the capital remaining after paying for the album will be used to cover the costs of editing the work "The Arachnological Fauna of Poland and the adjacent Countries." The special meeting of the physiographical committee, when the album is to be delivered to Prof. Kulczyński, will be held on March 24 at midday.

AT a special meeting lately held in the Berlin Royal Museum of Natural History, the committee for the exploration of the dinosaur-bearing deposits of German East Africa exhibited a few of the more remarkable specimens already received. The collection consists chiefly of the remains of Sauropoda, some much larger than the gigantic species of North America. One humerus measures more than 2 metres in length, and some of the cervical vertebræ are twice as large as those of Diplodocus. The leader of the exploring party, Dr. W. Janensch, reports the discovery of two new localities in which dinosaurian bones are abundant, and the chairman of the committee, Prof. W. Branca, is making an appeal for the gift of additional funds to continue the work.

THE discovery of Archæocyathinæ in a piece of limestone brought from the Antarctic continent by the Shackleton expedition, has excited renewed interest in these problematical Cambrian fossils. A typical series of specimens, obtained by Mr. Griffith Taylor, from South Australia, has accordingly been arranged for exhibition, with explanatory diagrams, in the Department of Geology, British Museum (Natural History). These organisms have now been discovered in the oldest fossil-bearing rocks in nearly all parts of the globe. Their form is that of two cups, one within the other, and their skeleton consists of granular calcite, not of spicules. The cups are pierced with perforations, and the space between the two is more or less subdivided by radial partitions and horizontal bars or plates, which are also perforated. The whole structure of the skeleton suggests that currents of water originally flowed through it, but its non-spicular construction prevents its reference to a sponge. It has even been compared with a calcareous alga, such as the existing Acetabularia, but the differences are so important that it is difficult to conceive of Archæocyathus as a primitive plant. In the museum the collection is placed between the Protozoa and the sponges.

WE record with regret the death, on March 9, of Colonel John Pennycuick, C.S.I., late R.E., at the age of seventy years. His name is best known in connection with the Periyar Diversion and the construction of the huge dam across the upper waters of the river Periyar, in the Travancore territory, and taking the water from the lake thus formed through a tunnel in the Western Ghats across to the opposite slope to supply the areas of the Madura district. Colonel Pennycuick was at the head of the Madras Public Works Department for several years, and retired in 1896, when he became president of the Royal Indian Engineering College at Coopers Hill, and held the post until the summer of 1899.

THE annual general meeting of the Ray Society was held on March 9, Dr. R. F. Scharff being in the chair. The report of the council stated that by the issue last year of part viii. of the "British Nudibranchiate Mollusca," for 1909, and of vol. ii., part ii., of the "British Annelids," for 1910, the publications had been brought up to date, and that for the present year two volumes were already in preparation, being vol. iv. of the "British Desmidiaceæ," with about thirty plates, and vol. iii. of the "British Tunicata," with sixteen plates, fourteen being coloured, completing that work. The balance-sheet showed a balance in hand of 55*l.* 2*s.* 8*d.*, with an investment of 1250*l.* Consols. The Right Hon. Lord Avebury was re-elected president, Dr. F. DuCane Godman treasurer, and Mr. John Hopkinson secretary.

AT the meeting of the Royal Geographical Society on March 13, Dr. T. G. Longstaff described his crossing of the Purcell Range in British Columbia in the course of last summer. This range lies parallel to, but is distinct from, the Selkirk Range, and both, while situated along-side the Rocky Mountains, are much older than the latter, representing in this region the original main axis of the North American Cordillera. The Purcell Range, like the Selkirks proper, attains no great height in its southern portion, but the northern half rises well above the snow-line in numerous glacier-clad peaks. The author was accompanied by Mr. Wheeler, a well-known Canadian mountaineer and topographer, who with theodolite and survey-camera made large additions to the survey of the region where the Dominion Government has of late suspended work to press forward that in more fertile areas. A large glacier which descends to the valley floor amongst the timber was visited, and its present phase was found to be one of retreat. Stations were occupied up to more than 8000 feet, and from the photographic survey 11,489 feet was determined as the height of the principal peak. This may be Mount Nelson or Mount Hammond, which, however, the author thinks may be identical. By the latter part of September it was necessary to leave the high valleys, after Mr. Wheeler had completed a considerable amount of surveying, and after the expedition had gained a general knowledge of the Purcell range and the location of its highest and most glaciated portions.

MR. R. A. LESLIE MOORE amused his audience at the Royal Society of Arts on February 24 by an account of Indian superstitions—omens, the evil eye, spooks and goblins, mystic animals, birds, insects, reptiles, trees, and so forth. The learned student of custom and tradition who is familiar with the abundant literature gathered on this subject in India will find little that is novel in this pleasant but rambling paper, or in the discursive remarks of Sir G. Birdwood and other Indian authorities which followed. But the paper will have a useful effect if only by directing attention to the vast, and still only partially garnered, material which India can supply.

THE recent death of Sir Francis Galton, the founder of the science of eugenics, naturally leads to a discussion in *The Fornightly Review* for March on the relation of eugenics to Mendelian genetics, contributed by Mr. G. C. Nuttall. The latter is working, and apparently on successful lines, to bring law and order into the inchoate mass of the facts of heredity; the former is striving to teach man to use his conscience, as well as his intellect, in dealing with this new knowledge. The writer believes it to be proved that feeble-mindedness could practically be stamped out in two generations if the State rigorously determined to check the perennial flow of the strain of the unfit into our national life. All this may be true; but the voice of the teacher is still that of one preaching in the wilderness. The remedy involves the seclusion of all persons defective in mind or body, a drastic method which our democracy, largely swayed by sentimental emotions, seems, for the present at least, not prepared to adopt.

THE Public Works Department of the Government of Egypt has published a second edition of the List of Animals in the Zoological Gardens at Giza, near Cairo, compiled by Captain Stanley S. Flower, the director, and illustrated by twenty plates reproduced from photographs. The names of species inhabiting Africa (inclusive of Madagascar), Arabia, and Syria are respectively indicated by an asterisk. An important feature of the work is a record of the number of years specimens have lived in the gardens since Captain Flower took over charge in 1898. At the annual census, taken in October, 1910, the total number of animals living in the gardens was 1464, referable to 391 species, both these figures being higher than in any previous year.

IN No. 1796 (vol. xxxix., pp. 489–93) of the Proceedings of the U.S. National Museum, Mr. R. L. Moodie describes a labyrinthodont from the Kansas Coal Measures, which is of interest alike on account of the rarity of such remains in that formation and from its own intrinsic characters; for this labyrinthodont, which is described as a new genus and species, *Erpetosuchus kansensis*, differs from all its relatives in the presence of a pair of oval vacuities on each side of the inner wall of the lower jaw, comparable to those of a crocodile, while it is further distinguished by the uniform character and shortness of its teeth. It is assigned to the family Labyrinthodontidæ. Greek scholars will regret that the genus was not named Herpetosuchus

TAKING as his text a statement by Mr. C. B. Devonport, to the effect that self-coloured fowls, as being more conspicuous, tend to be eliminated by natural enemies, whereas barred birds, on account of being less conspicuous, are more immune to attack, Dr. Raymond Pearl, in the February number of *The American Naturalist*, states that he has found the alleged contrast in regard to conspicuousness to be well founded. On the other hand, as the result of experiment, he denies the truth of the theory based on these facts. "We have been prone," he writes, "to agree that because an organism was coloured or formed in such a way as to be inconspicuous, it was, therefore, necessarily protected from attack by its enemies. . . . The logic of such reasoning is flawless. . . . But a conclusion may be perfectly logical and still not true. In the study of protective coloration, including mimicry, it is essential that a discovery that an organism is to human eyes inconspicuous or not readily distinguishable from some other organism shall not be considered the final goal."

THE recent appearance in vast numbers of the giant African snail *Achatina fulica* in Ceylon forms the subject of an article by Mr. E. E. Green in the February issue of *The Zoologist*. This bulimus-like species is a native of East Africa, but appears to have been introduced many years ago into Mauritius, where it is now common. To Calcutta it was introduced about half a century ago, and by 1877 was abundant in the gardens of the houses in Chominghi, while it had also crossed the Hughli to Howra and Barrakpur. About ten years ago a collector introduced the species on his estate in the highlands of central Ceylon, but soon after attempts were made to exterminate the intruders, and it was believed effectually. It appears, however, that some escaped destruction, and of these a couple were recently carried down with vegetables to the low country. Here they increased to such an amazing extent, over an area of about five square miles, that their numbers were to be reckoned by millions, no fewer than 227 being counted in a cluster on the stem of a cocoanut palm in a length of about 6 feet. Naturally the natives were in fear that their crops would be devastated; but, as a matter of fact, little or no serious damage has been inflicted, and it appears that the species largely acts the part of a scavenger, so that in some degree, at any rate, its introduction is a benefit. The adults are attacked by a terrapin of the genus Nicoria, and in its young stages the species probably has many foes. The enormous fecundity of these snails on their first introduction to the lowlands was probably a temporary phenomenon, and their numbers now appear to be diminishing.

DR. RUDOLF VON RITTER-ZÁHONY gives (Fisheries, Ireland, Sci. Invest., 1910, iv.) an account of the Chætognatha taken during the years 1905–6 off the coast of Ireland. As was to be expected in the surface waters of the temperate zone, the group is almost solely represented in the Irish epiplankton by *Sagitta bipunctata* and *Spadella cephaloptera*; *Sagitta serratodentata* also occurs, but is comparatively rare, and only a few young *Eukrohnia hamata* were observed. In the mesoplankton the first two forms were entirely absent; *E. hamata* predominated there, and with it were nine other species, some entirely confined to the mesoplankton, while others were found there only in the adult condition after having passed through their earlier stages of development in the epiplankton of warmer seas. In the same publication (v.) Messrs. E. W. L. Holt and L. W. Byrne give a list of 103 fishes of the Irish Atlantic slope, taken beyond the 100-fathom line, with references to the memoirs in which they are described.

AN insect pest of the camphor trees on the main island of Japan and Formosa, in the shape of a new species of the Psyllidæ, *Trioza camphorae*, is described by Prof. C. Sasaki in the Journal of the College of Agriculture, Tokio University (vol. ii., No. 5). The larvæ give rise to flattish button galls on the leaves.

THE first article in vol. xxviii. of the Journal of the College of Science, Tokio University, is devoted to short botanical studies from the tropics, by Prof. M. Miyoshi. Discussing the characters of tropical foliage leaves, he notes the tendency to produce firm entire leaves with a smooth or shining surface. Data are also supplied with regard to the manner in which leaves are wetted by rain. Another note refers to the Indian cherry tree *Prunus Puddum*, confirming the suggestion made by Sir J. D. Hooker that it is allied to the Japanese mountain cherry *P. pseudo-cerasus*, which it resembles in flower characters; from *P. campanulata* it differs markedly in the form of the fruit.

A THIRD paper embodying researches upon the sexual organs and reproduction in the cycad, *Dioon edule*, in this case dealing with fertilisation and embryogeny, is contributed by Prof. C. J. Chamberlain to *The Botanical Gazette* (December, 1910). In Mexico, fertilisation takes place during the month of April. The sperms escape through the ruptured end of the pollen tube with a small amount of liquid of high osmotic value, and one nucleus enters the egg, often slipping out of its ciliated sheath as it squeezes past the neck cells; it is suggested that the passage is prepared by the liquid issuing from the pollen tube, which plasmolyses the neck cells. After fertilisation a number of free nuclei are formed; then there is a distinct but evanescent formation of cell walls throughout the entire proembryo which only materialises into walls at the basal end where suspensor and embryo are differentiated.

EXPERIMENTS are continuously being conducted in the West Indies to obtain varieties of sugar-cane suited to the various soil and climatic conditions in the different districts of the islands. Numbers of new canes are raised from seed annually, and promising plants are carefully propagated; analysis is then made of the juice. Details of experiments conducted on these lines are given in Pamphlet No. 66, recently issued by the Imperial Department of Agriculture for the West Indies.

THE official forecast of the wheat crop of South Australia is put at 11·91 bushels per acre, this being 1·35 bushels fewer than the actual yield obtained twelve months ago. So late as last September it was thought that the present harvest would be 20 per cent. greater than the previous one, but an unusually severe attack of disease, locally known as "takeall," has since set in, and has in some cases destroyed entire crops. The disease is caused by the fungus *Ophiobolus graminus*, an interesting account of which occurs in *The Journal of Agriculture for South Australia* (No. 5). It is urged that a plant pathologist is needed for the study of crop diseases, which, according to the writer, cause a loss of nearly half a million of money each year in South Australia alone.

FROM the report of the Botanic Station, Experiment Plots and Agricultural School, Dominica, 1909–10, we learn that the general conditions of the gardens is satisfactory. A strong feature of the work is the distribution of material for planting purposes. More than 79,000 plants were sent out during the year, as well as large numbers of seeds. The experiments with economic plants include, among others, trials with spineless limes, varieties of citrus plants, Para rubber, and grafted cacao. The lime industry appears to be well established, and the conditions of production are steadily improving. Para rubber continues to do well in the wet districts of the island. Much remains to be done in improving the cacao industry; it is considered that the yield might be considerably higher if better methods were more generally used.

DR. E. J. BUTLER has been appointed director of the Agricultural Research Institute and College, Pusa, in place of Mr. Coventry, who is now Inspector-General of Agriculture in India. The annual report of the work of this institution describes the chief investigations carried on by the various departments. In the botanical department Mr. and Mrs. Howard are continuing their work on wheat, and are obtaining very promising results. Dr. Leather's work on the water requirements of plants is calculated to afford information valuable alike to the agriculturist and the irrigation engineer. Much attention is paid in the entomological department to industries that depend on the products of insects, eri, mulberry, tussor silk, and the cultivation of lac being the chief. The mycologist has carried out important investigations on the blister blight of tea and the palm disease in the Godavery Delta. A bacteriological section has been added, and a cotton expert appointed.

IN the *Bolletino della Società geografica Italiana* for February, Major A. Tancredi, who has done much to advance our knowledge of the climate of Eritræa, describes the salt plain lying to the east of the Abyssinian tableland. Situated at about 110 metres below sea-level, and forming an area of inland drainage, it has a mean temperature of about 31° C., while the maximum in summer is said to reach 50° C. From the salt deposits here formed, the Abyssinian merchants obtain the blocks of rock-salt which are used as currency throughout the country, rapidly rising in value towards the more remote western parts of the tableland. The volcano of Ert-Alé to the southward was seen from the hills above the Saline of Assale, but was not visited.

FROM the results of the Swedish expedition to Spitsbergen in 1908 under Prof. G. de Geer, we have received a first part containing the hydrographical observations by N. von Hofsten and S. Bock. The temperature and salinity of the sea were determined at about thirty points both on the outward and the homeward voyage. These factors showed a marked increase on the conditions which existed about 1902, when ice in August still surrounded the southern portion of Spitsbergen, and indicated a return to such as existed in 1898, when the Nathorst expedition could sail round Spitsbergen and visit Gills Land. The topography of Eisfjord, on the western coast of Spitsbergen, was studied during the second half of July and

August, as well as the hydrographical conditions, which showed that the warm salt Atlantic water flows into the fjord, and has there its temperature and salinity lowered by the glacier ice descending from the land.

In the Monthly Review of the Seismic Activity of the Earth's Crust, issued by the Kaiserl. Hauptstation für Erdbebenforschung in Strassburg, we find for June, 1910, references to forty-seven earthquakes. A few of these were destructive, but the greater number appear to have been local tremors. For each of these disturbances we have the date, the time (local and Greenwich), the character of the movement, its duration, direction, and general remarks. The fact that Japan records, on the average, 100 earthquakes per month, and the world probably experiences several thousands, it seems extremely likely that this publication will increase in size, but, as it stands, it must frequently be of great value in the interpretation of teleseismic records.

The Canadian Department of Mines has issued two advance chapters of the annual report on the mineral production of Canada during the year 1909. Each chapter is by Mr. John McLeish, chief of the division of mineral resources and statistics; one deals with the production of iron and steel in Canada in 1909, and the other with the production of coal and coke. The former industry showed a very satisfactory and steady growth as compared with previous years, but the coal-mining industry was marked during 1909 by a decreased production in Nova Scotia and an increased production in the western provinces, resulting in an aggregate decrease for the whole of Canada of 384,836 tons (short tons of 2000 lb.), or about 3½ per cent. Although iron ores are of wide occurrence throughout Canada, being found practically in every province, the development of these resources has not kept pace with the growth of Canadian metallurgical industries. About 17 per cent. only of the iron ore used in Canadian furnaces during 1909 was of domestic origin. Much of the coke and limestone also was imported, so that Canadian iron industries are now, and have been for a number of years, largely dependent on imported raw material. Coal mining has long been the most important of Canada's mining industries, and in 1909 is credited with 27 per cent. of the total mineral production of the country. The output in 1909 is more than twice that of ten years ago, about four times the output of twenty years ago, and nearly ten times the production of 1879. Notwithstanding its large coal resources, Canada's total coal production in 1909 was only about 56·4 per cent. of the estimated consumption, and the additional requirements were supplied by imports, chiefly from the United States.

The meteorological chart of the Indian Ocean for March, issued by the Meteorological Committee, quotes several cases of phosphorescent seas that have been observed in recent years. Among the most interesting is one forwarded to the Danish Meteorological Institute by Captain Gabe in the Strait of Malacca in June, 1909. Luminous waves were observed travelling from west to east, and gradually assumed the form of long arms, with dark intervals between them. These issued from an apparent focus, around which they rotated, which seemed to be on the horizon. An illustration of the phenomenon shows that the beams of light were somewhat curved, the concave edge being in the direction of rotation (clockwise). The brightness lasted about a quarter of an hour. A somewhat similar case of rotatory light system was observed by Captain Breyer in August last near the Natuna Islands, but the direction of rotation round the apparent focus in this instance was anti-clockwise.

In the *Verhandlungen der Deutschen Physikalischen Gesellschaft* for February 15, Prof. M. Planck removes one of the difficulties in the proof of his expression for the radiation from a perfectly black body. It will be remembered that the proof depended on the assumption that a simple Hertz oscillator could only possess an amount of energy which was an integral multiple of a certain small quantity of energy, or, in other words, that energy was atomic in structure, and emission and absorption of energy must take place by "atomic" steps. In the present paper Prof. Planck shows that, although emission must still take place in steps, absorption may be taken as continuous, and the amount of energy possessed by an oscillator at any instant may be a fractional number of "atoms." If, however, the probability that the oscillator emits an "atom" of energy be taken proportional to the whole number of "atoms" of energy it possesses, the fractional excess being disregarded, the final expression for the energy radiated by a perfectly black body in terms of temperature and wave-length becomes identical with that formerly given.

In a recent short publication of the Royal Observatory of Wilhelmshaven, the new director, Captain Capelle, explains how it is proposed to deal with arrears in the publication of magnetic work of that institution, and introduces a discussion of the magnetic character of the year 1910, by Prof. Bidlingmaier, who is now a member of his staff. Dr. Bidlingmaier regards the degree of disturbance of each individual hour as given by the numerals 0, 1, or 2, according to the extent of the departure of the corresponding portion of magnetic curve from the position characteristic of that hour on the average quiet day. The character of the hour is shown graphically by the colour of a small square, white, shaded, or black. The squares for adjacent hours and days are juxtaposed, so that the information is given for a whole month in a rectangular area about 80×65 mm., and that for a whole year in a couple of pages. Summing the numerical values for any specified number of hours, and taking the mean, a numerical measure is obtained for the average disturbance of the period, and certain conclusions are drawn as to the reality of 24-hour and 30-day disturbance periods. Whether the character of the hour is determined solely by reference to the horizontal force is not clear. A fuller explanation seems to be in view. The definition of disturbance presents a considerable resemblance to Sabine's, and whether it will commend itself to the general body of magneticians remains to be seen.

The Bulletins of the Cracow Academy of Sciences for 1910 contain three important papers by Prof. L. Bruner and his colleagues on photo-chemistry. The first action studied was that of light in promoting the conversion of maleic into fumaric acid in presence of bromine. In the absence of light, the bromine merely combines with the two acids to form dibromosuccinnic acids, the action proceeding fifteen times more quickly with maleic than with the more stable fumaric acid. In presence of light, perhaps because the bromination may become reversible, the main action is to cause the maleic to change into fumaric acid. This change, which is not effected in presence of chlorine or iodine or of the compounds ICl and ICl_3 was traced by measurements of conductivity and of solubility. The amount of fumaric acid finally produced depends on the nature of the light, but if this is fixed there is a definite ratio between the fumaric acid produced and the bromine used; by increasing the quantity of bromine, the maleic acid can be changed completely into fumaric acid. These observations reveal a striking contrast with catalytic actions in which light is not concerned, since the concentration of the catalyst is then without influence on the final equilibrium between isomers. Other characteristics of photo-chemical action were shown by the investigation of the bromination of toluene under the influence of light. This action is extraordinarily sensitive to the presence of oxygen, which appears to give rise to oxidised bromine-compounds which carry on the action after the light has been removed; bromination in the side chain can, indeed, be effected almost violently *in the dark* if the material is subjected to the action of slightly ozonised oxygen, which thus acts as a most efficient "carrier" of bromine to the side chain. When these disturbing effects were got rid of by exclusion of oxygen and the addition of a little iodine, the velocity of bromination was found to be independent of the concentration of the bromine, *i.e.* equal quantities of bromine were used in equal times throughout the action. The action of various wave-lengths of light was determined with the help of a mercury lamp and light-filters, but all wave-lengths absorbed by the bromine appeared to take part equally in the photo-chemical action.

AN account of a Garratt locomotive made by Messrs. Beyer, Peacock and Co., Ltd., of Manchester, for the Darjeeling-Himalayan Railway, appears in *The Engineer* for March 10. This railway is of 2 feet gauge, and presents peculiar difficulties on account of the steep ascent and frequent loops or spirals and reverses, one of the latter having gradients of 1 in 28. Curves of 70 feet radius are numerous. The specification for the locomotive included the condition that it should be able to travel over reverse curves of 60 feet radius with a length of tangent between the curves of 20 feet only. The engine consists of a girder frame, which is pivoted and supported at its extreme ends on four-wheeled bogies. Each bogie is a miniature locomotive *sans* boiler. The boiler supplying both is carried between the bogies on the girder frame. As there are no wheels under the boiler, the size of boiler is practically unrestricted. There are four cylinders each 11-inch diameter by 14-inch stroke, and fitted with Walschaert's valve gear.

PROF. EMIL FISCHER's lecture on "Neuere Erfolge und Probleme der Chemie," of which a translation appeared in NATURE of February 23, has been published by the firm of Julius Springer, Berlin, price 0.80 mark.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM AND ORBIT OF *o* PERSEI.—In No. 10, vol. ii., of the Publications of the Allegheny Observatory, Mr. Frank C. Jordan discusses the spectrum and orbit of the spectroscopic binary *o* Persei. From a discussion of seventy plates, taken with the Mellon spectrograph during 1908–9, he finds that, instead of a radial velocity of −3 km., as found by Vogel, the centre of the system has a radial velocity of +18·5 km.; the orbit is practically circular, and the period is 4·4192 days.

The most striking fact educed by Mr. Jordan, however, is that the H and K lines of calcium do not appear to participate in the displacements due to motion in the line of sight shown by the other lines. In other words, whilst helium, hydrogen, magnesium, and carbon lines in the star's spectra indicate that the star is revolving in a circular orbit, the H and K lines indicate that the calcium vapour producing them is moving with a constant velocity away from us. Prof. Hartmann found the same phenomenon in the spectrum of δ Orionis, and, as the apparent velocity derived from the K line differed by 7 km. from the velocity of the centre of the system, he suggested that the calcium absorption took place in a medium lying between us and the star; such a suggestion is strengthened by the fact that most stars exhibiting this peculiarity lie in nebulous regions. But Mr. Jordan is inclined to question the difference of 7 km., which might be obviated by adopting other standard values for the wave-length of K, and, very tentatively, suggests that a clue to the phenomenon may be found in the fact that, of eleven stars exhibiting the peculiarity, ten are strong helium stars.

THE DETERMINATION OF LATITUDE.—While the Talcott-Horrebow method of determining latitude is the most important from the point of view of accuracy and facility of application, it generally necessitates the use of a specially constructed instrument, the zenith telescope. But in No. 4481 of the *Astronomische Nachrichten* Mr. Kiyofusa Sotome, of the Tokio Observatory, explains how the method may be used in connection with an ordinary field theodolite. Three wires, one vertical and two others 45° from the vertical, cross at the centre of the field of the telescope, and are carried by a reticle in the focal plane. Then a pair of stars are observed, circle east and circle west, and the time-intervals between the transits are noted. Knowing the declinations of the stars, Talcott's method gives the latitude, after the application of various corrections. Mr. Sotome explains the method in detail with formulæ, and shows that reasonable errors in the time intervals will not seriously vitiate the results. A series of seven observations at Tokio gave a mean error of $\pm 0{\cdot}80''$, with a probable error of a single observation of $\pm 1{\cdot}63''$.

THE RELATION BETWEEN THE SEPARATION AND THE MAGNITUDE OF VISUAL DOUBLE STARS.—In No. 176 of the Lick Observatory Bulletins, Dr. R. G. Aitken analyses the degree of separation and the magnitudes of the double stars, brighter than magnitude 9·5 and closer than 5·0″, given in several large catalogues, and finds that the numbers of doubles consistently increase as one passes from the wider to the closer pairs. He also finds that the number of doubles of every distance-class under 5·0″ increases with increasing numerical magnitude; for instance, for B.D. stars as bright as magnitude 8·0 the proportion of doubles separated by less than 5·0″ is about 1 in 13½, but for B.D. stars between magnitudes 8·0 and 9·0 the proportion is only 1 in 25.

HALLEY'S COMET.—Already the periods of observation, both before and after perihelion, of Halley's comet, have easily exceeded those of any previous return; but observations are still being made at many observatories, and are likely to be continued for some time. M. Gonnessiat reports, in *Astronomische Nachrichten*, Nos. 4480–1, that on December 7 the magnitude was about 13·5, and that on February 25 it was 14·0.

In No. 4478 of the same journal Herr M. Ernst places on record his observations of the comet's magnitude on a number of dates extending from September 12, 1909, to June 30, 1910; his magnitudes for May 16 and 22, 1910, are −0·1 and −0·2 respectively.

THE PATH OF COMET 1886 I.—More than one hundred columns of the *Astronomische Nachrichten*, Nos. 4477–8, are taken up by an exhaustive discussion, by Dr. Erich Redlich, of the available observations of the large comet 1886 I. After giving and discussing each observation in detail, Dr. Redlich derives a set of elements which give the eccentricity of the orbit as $1{\cdot}0004461 \pm 0{\cdot}0000141$.

NOVA LACERTÆ.—The faintness of this nova and the almost persistent cloudiness of our skies have prevented any extensive recent observations. In No. 4476 of the *Astronomische Nachrichten*, however, Prof. Millosevich reports that on February 10 the magnitude was 8·8.

EARTHSHINE ON THE MOON.—To the casual observer of the heavens, the earthshine on the moon is deeply mysterious. On the evening of March 4, when our satellite was in conjunction with Saturn, the earthshine, as seen from Leeds, was unusually distinct, and many people, says Mr. J. H. Elgie in *The Yorkshire Post*, were led to believe that an eclipse was in progress. Mr. Elgie's observations showed that in the twilight the glow was of ashen hue, but that it deepened into olive as darkness came on.

OBSERVATIONS OF SATURN.—On September 29, 1910, Signor Mentore Maggini, of the Ximénien Observatory, Florence, observed a bright projection on the limb of Saturn, and announced his observation in No. 4445 of the *Astronomische Nachrichten*. In the current number of *L'Astronomie* (March, p. 114) he gives further details, illustrated by an excellent plate drawing of the planet. He also describes various other phenomena observed during many nights of excellent seeing in September and October. Among others, he notes the dark equatorial band as double, the northern part being formed of oval spots, which at moments of good seeing gave the band the appearance of a chaplet. A difference of colour between the two annuli of this double band was also noted, the more southerly band having a greenish colour, the other being more of a reddish hue. The bright equatorial band, usually yellow, was often disturbed by greenish-grey shadings. Festcons, similar to those seen on Jupiter by Mr. Scriven Bolton, were frequently noted, seven of them being seen on September 30, 1910. Many other interesting phenomena appertaining to the rings, &c., are recorded by Signor Maggini.

THE GALTON BEQUEST.

SIR FRANCIS GALTON, F.R.S., who died on January 17, at the age of eighty-eight, has left the residuary estate under his will, amounting to about 45,000*l.*, to the University of London for the purpose of encouraging the study of national eugenics, which is defined in the will as the study of "the agencies under social control that may improve or impair the racial qualities of future generations, physically and mentally." Primarily, the object of the bequest is the establishment and endowment of a professorship in the University to be known as "The Galton Professorship of Eugenics," with a laboratory or office and library attached thereto; and the testator expresses a desire, without binding the Senate of the University, that the professorship shall be offered to Prof. Karl Pearson, F.R.S. The new professor will collect and discuss materials bearing on eugenics, form a central office to provide information to private individuals or public authorities concerning the laws of inheritance of man, and will urge the conclusions as to social conduct which follow from such laws. In addition, he will be required to extend the knowledge of his subject by teaching and research. The wish is expressed that the Senate will supply the laboratory or office, preferably, in the first instance, in proximity to the Biometric Laboratory, which is at present under Prof. Pearson's control at University College.

By this generous benefaction, permanent provision will be made for the work which has been carried on in the Francis Galton Laboratory in the University since October, 1904. This work was initiated by Sir Francis Galton, who supplied funds amounting to 3500*l.* during his lifetime for its support. Apart from the cost of printing the publications of the laboratory, nearly the whole of the money available has been devoted to the payment of the staff of the laboratory, including the emoluments of the Galton research fellow (Mr. David Heron) and the research scholar (Miss E. M. Elderton). A large number of lectures have been delivered in connection with the laboratory, and these have been well attended. The publications of the laboratory include "Noteworthy Families (Science)," by Galton and Schuster; a series of memoirs, of which fifteen have so far been published; a series entitled "Questions of the Day and of the Fray" (one publication); and a lecture series (six publications); in addition, the staff of the laboratory has published a number of papers in *Biometrika* and other periodicals. The subjects of the publications cover a wide range, including the principles of heredity, with special reference to insanity, vision, alcoholism, and various diseases and deformities. Some of the publications, notably those on alcoholism, have given rise to vigorous controversy. The laboratory has been fortunate in securing the cooperation of a large number of men of science and medical men.

The report on the laboratory published in the appendix to the second report of the Royal Commission on University Education in London (p. 399) indicates in a brief manner the ideas of those controlling its work as to future developments. The Solvay Institute at Brussels is mentioned as a possible model of what the Eugenics Laboratory should become; but for such a scheme a capital expenditure of 20,000*l.* and an annual income of 4000*l.* would, it is stated, be required, or an annual income of 5000*l.* if a sinking fund were established to repay capital expenditure in twenty years. The staff would then include a director (800*l.*), a trained actuary (600*l.*), medical officer (600*l.*), and six assistants (1200*l.*), the balance being used for library, publications, upkeep of buildings, and sinking fund. Those who have visited the Solvay Institute at Brussels will realise the great boon which such a scheme would confer on students of social questions in London. The arrangements made for private workers in the Brussels institute are as perfect as could be devised. Each worker has a private room, and the resources of the institute in books and information are placed entirely at his disposal. In close proximity to the institute for social workers at Brussels, are similar institutes for research in physiology and other sciences.

It may be of interest to note, in conclusion, the clear indication expressed in the will of Sir Francis Galton's desire that the work for which he has so generously provided shall have a direct bearing on practical life and on legislation. This side of the work has given rise to many misconceptions as to the character of the new science, which is popularly suspected of proposing artificial restrictions on the community in connection with marriage and child-birth. It may be said that there is little in the publications of the laboratory staff to support this view, though other exponents of the subject have expressed themselves with greater freedom and less regard, perhaps, to scientific data. As a good example of the way in which the new subject may affect legislation, Prof. Pearson's lecture entitled "The Problem of Practical Eugenics" may be mentioned, in which the effect of factory legislation on the birth-rate is explained in simple, non-technical language. The lecture provides at once an object-lesson for legislators and an admirable illustration of the use of statistics in the study of social questions. T. LL. H.

STANDARD TIME IN FRANCE.

AT midnight on March 10 the clocks at the railway stations and all Government offices and municipal buildings of France and Algeria were set back nine minutes twenty-one seconds, to bring them in accord with Western European or Greenwich time, which will now be used in those countries, as it is in most other countries of Western Europe. The Paris meridian will, however, continue to be used as a standard for naval, astronomical, and cartographical purposes. A reform which has been urged in France for many years has thus at last been accomplished, and there can be no doubt as to the wisdom of the act, whether considered from the point of view of convenience or from that of international standards. It is not so much a question of the adoption of Greenwich time instead of Paris time as of France coming into a system of time-reckoning adopted by almost all the great countries of the world.

The zone-system of standard-time meridians separated by hours or half-hours, and encircling the globe, has undoubted advantages, and France occupied an anomalous position while it retained a time-standard having no simple relationship with the international system. The originator of this system was Sir Sandford Fleming, who, since he first suggested it in 1878, has done much to bring about the unification of time-reckoning throughout the world. Thanks to his persistent advocacy, twenty-four meridians are now recognised, beginning with that of Greenwich and counting towards the east. The time of each of these meridians is thus one hour behind that of the next meridian to the east of it, and one hour in advance of the next meridian to the west. Each meridian may be regarded as the median line of a zone 15° of longitude in width, so that the twenty-four meridians give standard-times on an organised system for the whole world. Local circumstances sometimes make it convenient to adopt the time of a meridian half-way between two of the twenty-four meridians, but this only means that the time will differ from other times in the system by an odd half-hour as well as an exact number of hours.

The subjoined table, adapted from one in "Hazell's Annual," shows the standard meridians used by various countries, with which France has now come into line:—

Standard Times.

Greenwich Time..	Great Britain, Spain, Belgium, Holland
1h. fast on Greenwich	Italy, Austria-Hungary, Switzerland, Germany, Denmark, Norway, Sweden
2h. fast	Cape Colony, Transvaal, Orange River Colony, Natal, Turkey, Egypt
4h. ,, ...	Mauritius and dependencies (except Chagos) and Seychelles
5h. ,, ...	Chagos Archipelago
5½h. ,, ...	India
6½h. ,, ...	Burma
8h. ,, ...	West Australia, Coast of China from Newchwang to Swatow, up Yangtse to Hankow, Hong Kong, Labuan, British North Borneo
9h. ,, ...	Japan, Philippines
9½h. ,, ...	South Australia
10h. ,, ...	Victoria, Queensland, New South Wales, Tasmania
11h. ,, ...	New Zealand
1h. slow	Iceland
	America—
4h. ,, ...	Atlantic
5h. ,, ...	Eastern
6h. ,, ...	Central
7h. ,, ...	Mountain
8h. ,, ...	Pacific

Russia, Portugal, and Ireland still remain outside the system; but perhaps the example now set by France in sacrificing national sentiment to a scientific principle will induce these countries to link up their times with those of other nations by the adoption of convenient meridians simply related to those of the international standards.

A LONDON INSTITUTE OF TECHNICAL OPTICS.

A SCHEME for the establishment of an Institute of Technical Optics has now been approved by the Education Committee of the London County Council, and will shortly come before the Council. The object of this scheme is the establishment in London of an Institute of Technical Optics for the widest possible training of opticians and optical instrument makers, and it is also hoped that valuable work may be done in connection with investigations in optical glass, for which this country now so largely depends upon imported supplies.

The Education Committee proposes that the Council shall grant 35,000*l.* for the building and equipment of the new institute, the site, valued at about 12,000*l.*, having been already provided by the Northampton Polytechnic Institute, under the direction of the governors of which the new institute will be maintained. To ensure that the work shall be on the best lines, it is proposed to appoint a consultative committee representative of the trade, scientific, and other organisations interested.

The new institute will be maintained from funds at present used to maintain the Technical Optics Department of the Northampton Polytechnic Institute, additional grants from the Board of Education, and additional contributions from the London County Council. Later it is hoped that, in view of the national character of some of the work which may be developed, assistance may also be obtained from imperial funds.

In the proposals under consideration, provision is made for the teaching of optical science with its technical applications, and of other subjects of value to the manufacturer and designer of optical instruments, and to the optician.

Such instruction will be given in day and evening classes, the former being arranged to train men for positions as captains of industry in the trade, while the latter will be chiefly concerned with improving the technical and scientific equipment of those already engaged in the trade. In addition to the necessary auxiliary subjects, such as mathematics, drawing, elementary physics, &c., the courses would deal with (*a*) the theory of optics and optical systems, the design of optical systems, the methods of manufacture, and the testing of lenses and other optical work; (*b*) the principles, design, and construction of optical instruments (such as telescopes, microscopes, spectroscopes, photographic apparatus, surveying and other instruments, &c.), their adjustment, testing, and use; (*c*) the manufacture, testing, &c., of spectacle frames and lenses; (*d*) physiological optics.

In the various courses suitable laboratory and workshop classes will be included. The day courses will train men, some of whom may be recruited from the universities, as designers, test-room and general technical assistants, or as retail opticians, the evening classes in corresponding branches supplying theoretical and laboratory knowledge to men already engaged in the trade.

Day classes are also proposed for boys who intend to enter the optical trades as lens workers or instrument makers; these courses would take the place of part of the time of apprenticeship; they would probably be on the general lines of such courses held in connection with other trades. In addition, workshop classes, associated with elementary theoretical classes, would be provided for workmen desirous of becoming foremen or of improving their work in special directions. Facilities for research work on technical problems will also be provided, and students encouraged to pursue such investigations under the direction of a carefully selected and capable staff. Special investigations of questions of general interest to optical instrument makers, as, for instance, the questions connected with optical glass, will also be undertaken.

The above is a bare statement of the character of the proposed institute, and the funds which it is hoped will be available for its establishment and maintenance. Nothing has been said of the very strong arguments upon which the case for the founding of such an institute rests. These are embodied in two elaborate reports covering nearly forty pages of foolscap print, and signed, respectively, by the education officer (Mr. R. Blair) and the educational adviser (Dr. Garnett) of the London County Council. The wide reaching and important character of the work to be undertaken is very fully set out, and it is scarcely too much to say that these reports contain food for serious thought for every scientific worker in physical, chemical, and natural science.

THE STEREOCHEMISTRY OF NITROGEN.

AT the end of December, 1909, attention was directed in these columns (vol. lxxxii., p. 266) to the preparation by Profs. Perkin, Pope, and Wallach of an acid of the formula

$$\begin{matrix}H \\ CH_3\end{matrix}\!>\!C\!<\!\begin{matrix}CH_2-CH_2 \\ CH_2-CH_2\end{matrix}\!>\!C=C\!<\!\begin{matrix}H \\ COOH\end{matrix}$$

which contained no asymmetric atom, but which was capable of existing in two enantiomorphous forms—each having a large optical rotatory power—because the molecule, as a whole, was devoid of any plane of symmetry.

This important method of investigation has been extended to the stereochemistry of nitrogen by Dr. W. H. Mills and Miss Bain, whose observations are recorded in the Chemical Society's Journal. The substance investigated was the oxime of the formula

$$\begin{matrix}H \\ HO.CO\end{matrix}\!>\!C\!<\!\begin{matrix}CH_2-CH_2 \\ CH_2-CH_2\end{matrix}\!>\!C=N.OH.$$

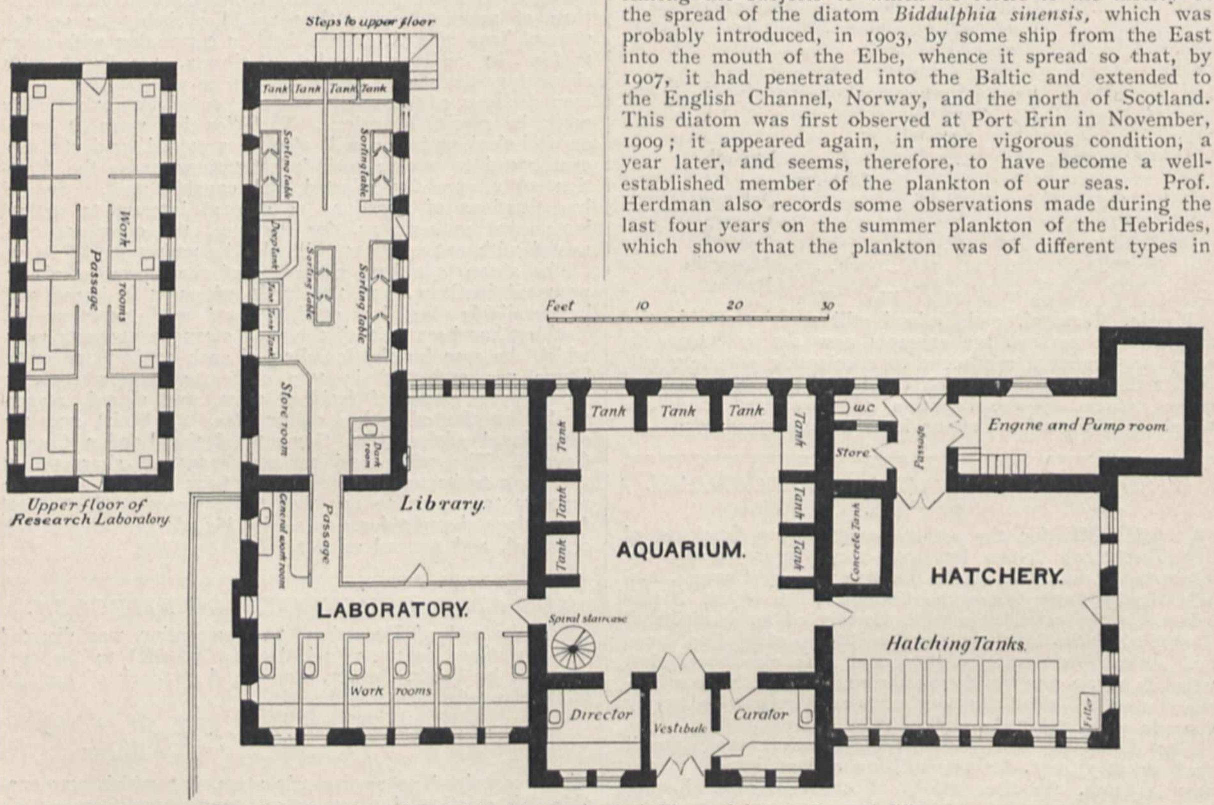
This oxime is obviously not symmetrical on either side of the plane of the ring, but would possess a plane of symmetry perpendicular to the ring if it could be assumed that the hydroxyl-group is situated in this median plane. The view that the hydroxyl-group is not situated in the plane of the remaining valencies of the nitrogen atom was advanced by Hantzsch and Werner in order to account for the isomerism of certain aromatic oximes, but was based upon somewhat slender evidence. In the case of the oxime formulated above, the matter can be tested directly by determining whether it can exist in optically active forms or not. The experiments show that the resolution of the oxime can actually be effected by means of morphine or quinine. It has a high rotatory power, not less than

$[M]_D \pm 91°$, but this is evanescent, the compound racemising rapidly and becoming inactive in the course of a few minutes or hours.

From its marked optical activity, it is clear that the oxime is asymmetrical in its structure; this probably applies both to the hydroxime $>C=NOH$ and to the isoxime $>C<\genfrac{}{}{0pt}{}{NH}{O}$ forms of the compound, but further work with derivatives of both types would be of great value in determining the range over which the lack of symmetry extends.

MARINE BIOLOGY AT PORT ERIN.

THE twenty-fourth annual report of the Liverpool Marine Biology Committee, dealing with the year's work of the Port Erin Marine Biological Station, affords ample evidence of the continued activities of this station. Details are given of the recently built research wing, the equipment of which is being pushed forward so as to be ready for use during the coming Easter vacation. This wing, 44 by 18 feet, two storeys high, contains on the ground floor a photographic dark-room, and a large and two smaller tank-rooms suitable for experimental work in biochemistry, comparative physiology, and embryology of marine animals. These three well-lighted rooms have cemented floors and walls, and are well provided with concrete tanks, of different sizes and depths, over which there are taps giving abundant supplies of sea water. Over a large central concrete platform, on which aquaria can be placed, will be a "plunger" apparatus for keeping in motion the water in the aquaria in which small animals are being reared. The upper floor contains eight separate rooms, each with about 13 feet of working bench, a sink, and supplies of fresh and sea water, which make an excellent addition to the accommodation available to research workers and senior students.



Plan of the Port Erin Biological Station, showing both Floors of the new Research Wing.

The report gives an account of the work done in the first course on oceanography, held at the station during August last. The usual work of the laboratory, in connection with research and the instruction of senior students, has been carried on; fifty-seven researchers and students have occupied the working places during the year. Mr. Riddell, who has been collecting the Polychæta, reports the addition to the previous records for Port Erin of twenty-eight species. A note by Dr. Roaf, on his investigations on the secretion of the hypobranchial gland in *Purpura lapillus*, states that the purple-forming area of this gland is the site of formation of an adrenalin-like substance. The operations of the fish hatchery at the station have resulted in the liberation into the sea of more than eight millions of plaice larvæ and five thousand lobster larvæ.

The concluding portion of the report contains an account, by Prof. Herdman, of his plankton observations. Among the subjects to which he refers is the history of the spread of the diatom *Biddulphia sinensis*, which was probably introduced, in 1903, by some ship from the East into the mouth of the Elbe, whence it spread so that, by 1907, it had penetrated into the Baltic and extended to the English Channel, Norway, and the north of Scotland. This diatom was first observed at Port Erin in November, 1909; it appeared again, in more vigorous condition, a year later, and seems, therefore, to have become a well-established member of the plankton of our seas. Prof. Herdman also records some observations made during the last four years on the summer plankton of the Hebrides, which show that the plankton was of different types in different localities, but preserved a constant character in each; appended are some suggested explanations of the facts.

THE METHOD OF SCIENCE.[1]

SCIENCE governs human life by determining the conditions of existence and by furnishing the means of civilisation. Religion prescribes the motives, government formulates the customs of mankind, science fixes what we can do and how. If, at the present meeting, we appropriately emphasise the *rôle* of science, it does not imply that we belittle the ethical or social factors of civilised life, but answers the demand for a more just and general recognition of the actual importance of pure science.

We are so accustomed to the practical advantages that have followed from abstruse science, that we connect them

[1] From an address delivered by Prof. C. S. Minot as president of the Section of Physiology and Experimental Medicine of the American Association for the Advancement of Science, at Minneapolis, December 29, 1910.

with their source only by a distinct mental effort. The wonders of practical science have been recited so often that their reiteration has become tedious, and we no longer feel strongly impelled to felicitate mankind on the parlour match, the telephone, and the antitoxins, although we indulge at present in an unsubdued, excited anticipation of wonders to come, especially in the domain of medicine. Are we not all on the watch for the announcement of the cure for cancer, and vaguely for other new and astounding reliefs from disease? Such concentration of interest upon novel practical results is not wholly favourable to science.

It is true that a large amount of investigation is going on which aims to secure immediate practical results. In chemistry and medicine especially, the activity in the work of applied science is very great. This condition gives a powerful fresh reason for defending pure, abstruse science. Applied science always has been, is now, and probably always will be, distinctly subsidiary to pure science. The final justification of all scientific research is undoubtedly the power it creates for the use of mankind, but the power must be created before it can be used. A little study of the history of science should suffice to convince any reasonable mind that the command we possess to-day over nature is due to the labours of men who have almost invariably pursued knowledge with a pure devotion uncontaminated by any worship of usefulness. These devoted idealists have gathered the varied mighty harvests by which all men have profited, but the debt of gratitude to them is unpaid.

The pursuit of abstruse science needs to be encouraged. It is insufficiently esteemed. This doctrine ought to be emphasised on all suitable occasions, but especially before the section of experimental medicine. The people cry for relief from sickness, and their demand for prompt, useful discoveries is so urgent that there is danger in it, since it tempts medical investigators away from the fundamental inquiries, which, answered, will give great results, and seduces them to work exclusively at secondary problems, from the solution of which quicker, but smaller, results may be expected. Pure science is broad; it embraces all. Applied science is a congery of fragments, of isolated problems, which lack cohesion and are without any necessary connection with one another. It is easy to understand why students of applied science have seldom made great discoveries.

In fact, scientific knowledge will not be compelled. We have to take what knowledge we can get, and by no means can we get always what knowledge we want. Pure science adapts its undertakings to these rigid conditions, and works where the opportunity is best—not so applied science.

Compared with the growth of science, the shiftings of Governments are minor events. Until it is clearly realised that the gravest crime of the French Revolution was not the execution of the king, but the execution of Lavoisier, there is no right measure of values, for Lavoisier was one of the three or four greatest men France has produced.

Since pure science has been pre-eminent in the past, not only in furnishing useful knowledge, but also as a chief foundation of human progress, and is likely long to continue equally pre-eminent, it is well worth while to study the general principles by which original research is guided. No previous definite study of these principles is known to me, although I have searched not a little to find one. All that I have been able to discover are treatises on logic, the reading of which, most active investigators would, I fear, find tedious and unprofitable rather than helpful and inspiring.

It is my belief that the logical work of scientific men is usually well done, and is the part of their work which is least faulty. The difficulties and the majority of failures are due, it seems to me, to two chief causes, the first, inadequate determination of the premises, the second, exaggerated confidence in the conclusions. If I am right, the method of science is the result of the effort to get rid of these two causes of error.

We must recognise in starting that the expression "the method of science" means more than "logic," being far more comprehensive when rightly defined. We cannot alter the fundamental conditions of knowledge, for we are still unable to add new senses or improve the brain—although eugenics dreams of a future with such possibilities—nor can we change the nature of the phenomena. The same fundamental resources are available for daily life and for science. We must be clear in our minds on this point, in order to comprehend that the fundamental distinction of the scientific method is its accuracy. Such being the case, a broad examination of the method of science reduces itself to the study of the general principles of securing accuracy.

If you will examine frankly your own opinions and those of your acquaintance, you will, it may be presumed, quickly acknowledge that many, perhaps most, of the opinions are not of scientific accuracy. On the contrary, they are, to a large extent, mental habits and the result of the summation and averaging of impressions. We get along in ordinary life satisfactorily enough with opinions thus formed by summation. Most human opinions, even when they are merely imitative, originate in this way, and are correspondingly untrustworthy. If we seek to explain the fallibility of ordinary opinions and testimony, must we not attribute it to the absence of the detailed evidence and the consequent impossibility of verifying the testimony?

We are thus led to recognise the preservation of the evidence as the fundamental characteristic of scientific work, by which it differs radically from the practice of ordinary life. I venture, accordingly, to define the method of science as the art of making durable, trustworthy records of natural phenomena. The definition may seem at first narrow and insufficient, but I hope to convince you that it is so comprehensive as to be not only adequate, but also almost complete.

All science is constructed out of the personal knowledge of individual men. Science is merely the collated record of what single individuals have discovered. Accordingly, we must consider, first, the way in which the individual knowledges are recorded and collated. The process begins, of course, with the publications of the special scientific memoir in which the investigator records his original observations and makes known his conclusions.

It is interesting to note that our present standards for original memoirs have developed gradually. In Harvey's essay on the circulation of the blood, published in 1628, there are no precise data as to his observations. The author does not think it necessary to specify how he has laid bare the heart or how often he has repeated his observations. His descriptions of the beating heart are vividly realistic. He writes with conviction and authority. The reader is compelled to believe him. Harvey, however, does not provide information to facilitate repetition of his work—he offers little aid towards the verification of his results.

In a contemporary article we expect a presentation of all the data necessary to render subsequent verification by other observers possible. We further expect clear information as to the amount of material on which the observations were made, or the number of experiments on which the work is based. In other words, a modern investigator will hardly receive consideration for his researches unless he furnishes every aid he can to facilitate criticising and testing his results. This severe standard has been only gradually evolved, but is now stringently enforced in all departments of science, and is the response in our practice to our need of eliminating the purely personal factor. It would be advantageous if scientific authors, generally, viewed the obligation of providing for verification as an even more serious duty than it is esteemed at present. It might, indeed, be a wholesome practice to demand that every scientific article should contain a special section or paragraph on the means of verifying the result, for verification by *Fachgenossen* is second in importance only to discovery in the progress of science.

The conditions of scientific progress have changed greatly, though very gradually. Two hundred years ago the number of active investigators was small. This year there are at least ten thousand men of substantial ability carrying on original researches, consequently each theme is being worked at by several men, and the final outcome is the consequence of collaboration, which is none the less actual and effectual because it is unorganised, and is usually not formally designated as collaboration.

These conditions have rendered great men somewhat less important than formerly. Science grows by the accretion of ideas. Now, a great man has, let us say, twelve new ideas, where a man of ability has one. If science gets twelve new ideas, it matters little whether they come from one man or from twelve. To a certain extent, numbers make a substitute for genius—but nothing probably will ever replace that type of great genius, to which we owe most, the man who has a great thought, which no one has ever conceived before.

The nineteenth century, in response to the new conditions which have arisen in its course, has added another new standard for scientific memoirs—they must include a conscientious consideration of recent and co-temporary related work. Now the second step in science-making, after recording the new original observations, so as to make them accessible to others, is the collation of these same observations into broad general results. The aim is to eliminate the personal factor and to impart the character of impersonal, absolute validity to the conclusions.

In addition to the original memoirs, science profits by a large number of publications, almost all of which are of modern, often of very recent, creation. Broadly speaking, their aim is to promote that collation which is begun in the original memoirs. Germany is the home of most of these undertakings, which are familiar to us under the names of "Jahresberichte," "Centralblätter," and "Ergebnisse."

We recognise in the present methods of recording and collating scientific discoveries many adaptations which are due, it seems to me, essentially to the mere increase in the number of workers. But though the methods are modified, the essential steps are the same: first, the record of the individual personal knowledge; secondly, the conversion of the personal knowledge by verification and collation into valid impersonal knowledge; thirdly, the systematic coordination and condensation of the conclusions.

A defect—perhaps the most serious defect of our education—arises from our failure to make our students appreciate vividly the fundamental fact that science is based on personal knowledge. Our students are allowed to graduate from college, for the most part, without any comprehension of this great truth. The best of them start forth with a high reverence for the library, the place of records, but quite unaware that a still higher reverence is due to those who, by being the first to observe unknown things, have founded the knowledge the records of which the library keeps.

The divergence between philosophy and science shows itself most conspicuously in the personal mental attitude which philosophy cherishes and science seeks to overcome. Philosophers still discuss philosophers and their systems, scientific men pursue impersonal knowledge with such ardour that they are apt to know little of the history of science.

The records which we have considered thus far are those which serve to make the discoveries of individuals available for others. So soon as the discoveries are properly collated and sufficiently verified, they become permanent parts of science. Many definitions of science have been given, and did time permit it might be profitable to quote some of them—but is it not sufficient to define science as *knowledge which has acquired impersonal validity*?

We must now attempt a general examination of the records, which are used primarily to help the original investigator, though often preserved to assist his successors. The simplest form of record is the preservation of the actual specimen. Scientific museums are essentially storehouses for such records. Most of them, to be sure, maintain public exhibitions, which interest, stimulate, and possibly instruct the public, but the precious part of their collections comprises the objects possessed, which have served for some original discovery. Scientific museums are very modern; nearly all those in America have been started within a few years.

The progress of science is marked by the advance in the art of making research records. We all admit, in other words, that the progress of science depends partly on the perfecting of old methods, but chiefly on the invention of new ones. Despite the enormous variety in their nature and aims, all our technical methods have this in common—that their real purpose is to yield us records. Our microscopes, spectroscopes, measuring instruments, and many another apparatus have indeed their primary scope in rendering possible observations which are impossible with our unaided senses. They enlarge our field of inquiry, and put precision within our reach. Yet their usefulness is conditioned upon their enabling us to make records which else would remain beyond our power. On the other hand, there is a still larger class of apparatus which are obviously designed to make records. What has been said concerning apparatus might be repeated concerning methods.

It is remarkable that the vast majority of methods and apparatus are contrived to furnish a visible result. Sight has long been acknowledged by science as the supreme sense. Perhaps the philosopher was right who asserted that nothing is really known until it is presented in a visible form. We biologists cannot deplore too frequently or too emphatically the great mathematical delusion by which men often of very great, if limited, ability, have been misled into becoming advocates of an erroneous conception of accuracy. Although I have expressed myself on the subject before, its importance justifies recurring to it. The delusion is that no science is accurate until its results can be expressed mathematically. The error comes from the assumption that mathematics can express complex relations. Unfortunately, mathematics have a very limited scope, and are based upon a few extremely rudimentary experiences which we make as very little children, and of which, probably, no adult has any recollection. The fact that from this basis men of genius have evolved wonderful methods of dealing with numerical relations should not blind us to another fact, namely, that the observational basis of mathematics is, psychologically speaking, very minute compared with the observational basis of even a single minor branch of biology. Moreover, mathematics can at the utmost deal with only a very few factors, and cannot give any comprehensive expression of the complex relations with which the biologist has to deal. While, therefore, here and there the mathematical methods may aid us, we need a kind and degree of accuracy of which mathematics is absolutely incapable. For our accuracy it is necessary often to have a number of data in their correct mutual relations presented to our consciousness at the same time, and this we accomplish by the visual image, which is far more efficient for this service than any other means of which we dispose. When we wish to understand a group of complex related details, such as an anatomical structure, we must see them, and if we cannot see them no accurate conception of the group can be formed.

With human minds constituted as they actually are, we cannot anticipate that there will ever be a mathematical expression for any organ or even a single cell, although formulæ will continue to be useful for dealing now and then with isolated details. Moreover, biologists have to do with variable relations, some of which, of course, can be put into mathematical form, but we find that even the simplest variations become clearer to us when presented graphically. The value to every student of science of the graphic method has been immense. Biologists can work to advantage with quantitative methods, we welcome the increasing use of measurements in biology, we welcome the English journal *Biometrika*, the organ of the measuring biologists—but none the less we refuse to accept the mathematical delusion that the goal of biology is to express its results in grams, metres, and seconds. Measurements furnish us with so-called "exact" records, but the aim of science goes beyond the accumulation of exact records to the attainment of accurate knowledge, and the accuracy of our knowledge depends chiefly on what we see. The practice of science conforms to this principle, the definite affirmation of which may prove of continuing advantage.

No class of records illustrates the value of sight in science more impressively than those made by instruments for registering the time factor. The kymographion invented by Carl Ludwig is the prototype of many apparatus. In them all, a succession of events, like heart beats, for example, together with marks showing the time, are so registered that they can be seen simultaneously, and thus readily compared. If no such apparatus were available, much of our most important scientific knowledge would not exist. To deprive mankind of microscopes or telescopes would be hardly a more serious blow to science. We do not, of course, depend on our eyes for the notion of time—for the congenitally blind perceive time—but so soon as we wish to know accurately the relation of changing events to time intervals, we depend upon having them recorded in a visible form. It is the practical acknowledgment of the superiority of the eye as an agent to make clear the correlation of data.

Scientific men base their work upon a series of assumptions: first, that there is absolute truth, which includes everything we know or shall know; secondly, that we ourselves are included in this absolute truth; thirdly, that objective existence is real; fourthly, that our sensory perception of the objective is different from the reality. These conceptions constitute our fundamental maxims, and even when not definitely put in words they guide all sound scientific research. Metaphysicians find such maxims interestingly debatable; but science applies them unhesitatingly, and is satisfied because their application succeeds. Philosophy, ever a laggard and a follower after her swifter sister, has lately, and somewhat suddenly, termed the scientific habit of work pragmatism, and has taken up the discussion of it with delightful liveliness. Let us acknowledge the belated compliment and continue on our way.

The practical result of the four maxims has been that we further assume that all errors are of individual human origin, and that there are no objective errors. We make *all* the mistakes, nature makes none. To render the pursuit of new knowledge successful, our basic task is to eliminate error, or in other words to decide when we have sufficient proof. The elimination of error depends primarily upon insight into the sources of error, which, since methods of all sorts are employed, involves an intimate technical acquaintance with the methods, with just what they can show, with what they cannot show, and with the misleading results they may produce. In the laboratory training of a young scientific man, one chief endeavour must always be to familiarise him with the good and the bad of the special methods of his branch of science. Not until he thoroughly understands the character and extent of both the probable and the possible errors is he qualified to begin independent work. His understanding must comprise the three sources of observational error, namely, the variation of the phenomena, the imperfections of the methods, and the inaccuracy of the observer. The personal equation always exists, although it can be quantitatively stated only in a small minority of cases.

The history of science at large, the history of each branch of science, and the personal experience of every active investigator, all equally demonstrate that the greatest source of error is in our interpretations of the observations, and this difficulty depends, it seems to me, more than upon any other one factor; upon our unconquerable tendency to let our conclusions exceed the supporting power of the evidence. Since generalisation is the ultimate goal, we are too easily inveigled into assuming probabilities to be certainties, and into treating theories, and even hypotheses, as definite conclusions. Each generation of investigators in its turn spends much time killing off and burying older erroneous interpretations. The business is seldom accomplished by direct attack, for error perishes only in the light of truth, as micro-organisms are said to perish suddenly when struck by ultra-violet rays. Owing to the load of false theories, we work like a mental chain-gang, and are never unfettered. The handicap imposed by wrong hypotheses has always impeded the growth of science.

The multitude of such experiences, great and small, has gradually created among scientific men a special highly characteristic mental attitude. They regard the majority of the accumulated data and many of the inductions of science as correct. This is their estimate of the great body of information which, though personal in its origin, has been in the course of time so tested and verified that it is looked upon as established and secure. When Asellus in 1622 discovered the lymphatics, or so-called lacteals, of the mesentery, and demonstrated that they convey products of digestion from the intestine, his knowledge was his own, and at first his only. Since then the observations have been repeatedly verified, and of course extended, and all uncertainty has vanished from our minds. Similarly, in innumerable other cases reasonable impersonal certainty has been attained. Yet the investigator lives in an atmosphere of concentrated uncertainty, for he is convinced that at any time new data may turn up, and that all generalisations are likely to require modification. We might well adopt as our cry: Incredulity towards the known; open credulity towards the unknown.

We think of science as a vast series of approximations, and our task is constantly to render our approximations closer to absolute truth, the existence of which we take for granted. We use our approximations as best we may, treating them in large part and, at least for the time being, as if they were accurately true, yet meanwhile we remain alert to better them. This has long been the standard of scientific thought. It is the pragmatic attitude of mind, but its new name has not rendered it a novelty.

The pivot of all research is adequate proof. It would certainly aid science if some competent philosopher should make a study of the practice of investigators in the various branches of science sufficient to render clear the general principles by which investigators decide when a new observation or a new induction is sufficiently proven. If we follow the advance of research in any particular direction, we soon realise that there is a more or less definite standard of proof, which, though never clearly formulated, is none the less insisted upon, so that any paper which does not come up to this standard is subject to unfavourable criticism. Two elements of this standard we know, the first the elimination of the recognised sources of error, secondly, the repetition of the observations so that the constancy of the phenomenon is assured. We cannot do more than allude to this theme, which I must leave to the future and to a more competent mind to analyse and develop.

To sum up. The method of science is not special or peculiar to it, but only a perfected application of our human resources of observation and reflection—to use the words of von Baer, the greatest embryologist. To secure trustworthiness, the method of science is, first, to record everything with which it deals, the phenomena themselves and the inferences of the individual investigators, and to record both truly; secondly, to verify and correlate the personal knowledges until they acquire impersonal validity, which means, in other words, that the conclusion approximate so closely to the absolute truth that we can be safely and profitably guided by them. The method of science is no mystic process. On the contrary, it is as easily comprehended as it is infinitely difficult to use perfectly, and at its best the method supplies merely available approximations to the absolute.

We set science upon the throne of imagination, but we have crowned her with modesty, for she is at once the reality of human power and the personification of human fallibility.

THE CALORIC THEORY OF HEAT, AND CARNOT'S PRINCIPLE.[1]

THE caloric theory of heat as developed by Carnot in his famous "Reflexions on the Motive Power of Heat" (Paris, 1824) leads immediately to the correct solution of the relations between heat and motive power (energy or work) in all reversible processes, and appears to be in some respects preferable to the mechanical theory as a method of expression, because it emphasises more clearly the distinction, first clearly stated by Carnot, between reversible and irreversible transformations, and because it directly provides the natural measure of a quantity of heat as distinct from a quantity of thermal energy.

Carnot first introduced the method of the cyclical process in discussing the action of a heat engine, and showed that, in the ideal case, if there were no direct transference of heat between bodies at different temperatures, the transformations of heat and motive power in such a cycle were reversible. Assuming that it was impossible to

[1] Abstract of the presidential address delivered before the Physical Society on February 10 by Prof. H. L. Callendar, F.R.S.

imagine a heat engine capable of producing motive power perpetually without taking any heat from the boiler, he concluded that the quantity of motive power, W, produced from a given quantity of heat, Q, by means of a reversible engine, working between given temperature limits in a cyclical process, was the maximum obtainable, or that the efficiency must be independent of the agents employed, and must be a function of the temperature limits alone. He expressed this by the equation $W/Q=F(t)$, between finite limits o° and t° C., or by the equivalent equation $dW/dt=QF'(t)$ for a cycle of infinitesimal range, dt, at a temperature, t, where $F'(t)$ (generally known as Carnot's function) is the derived function of $F(t)$, and must be the same for all substances at the same temperature.

Applying the equation in this form to a gas obeying the law $pv=RT$, he showed that the heat absorbed in isothermal expansion from v_0 to v was given by the expression $Q=R\log_e(v/v_0)/F'(t)$, and that the difference of the specific heats at constant pressure and volume, given by the expression $S_p-S_v=R/TF'(t)$, must be independent of the pressure, and the same for equal volumes of all gases. These results were new, but were confirmed experimentally by Dulong five years later. Carnot showed, further, that if the ratio S_p/S_v was constant (as found by Gay Lussac and Welter, and assumed by Laplace and Poisson), both S_p and S_v must be independent of the pressure.

The results so far obtained by Carnot, including the description of his reversible cycle and the deduction of his fundamental principle, were independent of any assumption as to the nature of heat. Applying the assumption of the caloric theory, that the quantity of caloric required to change the state of a substance from (v_0, t_0) to (v, t) was the same by any reversible process, Carnot deduced that, if S_v was independent of the pressure, the function $F'(t)$ must be constant, $=A$. This assumes that heat is measured as caloric, and that temperature is measured on the scale of a gas, obeying the law $pv=RT$, and having S_v independent of the pressure, which is equivalent to the modern definition of a perfect gas. Putting $F'(t)=A$, he obtains for the work W produced from a quantity of caloric, Q, supplied at a temperature, T, in a cycle of finite range T to T_0, an expression equivalent to the following:—

$$W=AQ(T-T_0).$$

Carnot was unable to reconcile this solution with the imperfect experimental data available in his day, and particularly with the observation of Delaroche and Bérard, supported by Laplace's theory, that the specific heat of air, S_p, diminished with increase of pressure, which we know now, from the experiments of Regnault, to have been incorrect. He therefore made no serious attempt to apply the solution, and subsequent writers have apparently failed to observe that it is the correct final solution of the problem on the caloric theory. With our present knowledge, it is easy to see that this solution of Carnot's is also consistent with the mechanical theory, and contains implicitly all the relations of heat and work so far as they relate to reversible processes. The quantity, Q, of caloric remains constant in reversible expansion, such as is postulated by Carnot, when no heat is supplied. The work done is directly proportional to the temperature range $T-T_0$. The absolute motive power or equivalent work-value of a quantity of caloric, Q, supplied at a temperature, T, is the maximum work obtainable from a perfect gas (and therefore from any other substance whatever) when $T_0=0$, namely, AQT. The efficiency of the cycle with range T to T_0 is $W/AQT=(T-T_0)/T$. The external work done in the cycle is the difference of the work-values of the caloric supplied and rejected, a result which is readily extended to cycles of any form.

To complete Carnot's solution, it is necessary to inquire what happens to caloric in irreversible processes, such as friction, or the direct passage of heat from a hotter to a colder body. Carnot, as we see from his posthumous notes, had already, before his early death in 1832, arrived at the general conception of the conservation of motive power, and had planned experiments in which the motive power consumed in friction should be measured at the same time as the caloric generated. According to his theory, it would have been natural to assume that the motive power of the caloric generated at any temperature, namely, AQT, should be equal to the motive power consumed in friction. But he realised that further experimental evidence was necessary, which was first supplied by Joule.

A quantity of caloric is defined in Carnot's equation as measured by work done in a Carnot cycle per degree fall. The absolute unit of caloric, which may appropriately be called the *carnot*, is that quantity which is capable of doing one joule of work per degree fall. The mechanical equivalent of Q carnots at T abs. is QT joules. From Carnot's data, the work done in a cycle per gram of steam vaporised at 100° C. per degree fall is 0·611 kilogrammetres, or nearly 6 joules. The caloric of vaporisation is 6 carnots. Similarly, from Kelvin's data for the pressure required to lower the freezing point 1° C., the caloric of fusion of ice is 1·2 carnots. Since this definition is independent of calorimetric measurements, it may be employed in a calorimetric test, in which steam is condensed at 100° C. on one side of a conducting partition, while ice is melted at 0° C. on the other, to determine by direct experiment what happens when caloric falls irreversibly by conduction from 100° C. to 0° C. We know that for each gram of steam condensed, or for each 6 carnots supplied at 100° C., 540/79·5 grams of ice approximately would be melted, or 8·17 carnots of caloric would appear at 0° C. The quantity of caloric is increased in the proportion 373/273. The motive power of the caloric remains constant if no useful work is done. The increase of the quantity of caloric is the same as if the available motive power AQ(T−T) had been developed and converted into heat by friction at the lower temperature. Whenever motive power is wasted in friction, or "in the useless re-establishment of the equilibrium of caloric," a quantity of caloric equivalent to the wasted motive power is generated. The total quantity of caloric in an isolated system remains constant only if all the transformations are reversible, in which case the motive power developed exactly suffices to restore the initial state. In all other cases there is an increase of caloric. The old principle of the universal conservation of caloric, which is true only for reversible processes, must therefore be modified as follows:—"*The total quantity of caloric in any system cannot be diminished except by taking heat from it.*"

This principle, with various modifications to suit special cases (such as conditions of constant temperature, pressure, or volume), is immediately recognised as one of the most fruitful in modern thermodynamics. But it appeals more forcibly to the imagination of the student, if established, as roughly sketched above, by a direct investigation of the properties of Carnot's caloric.

The caloric theory is seen to be perfectly consistent with Carnot's principle and with the mechanical theory for all reversible processes. Caloric is the natural measure of a quantity of heat in accordance with Carnot's equation if we adopt the gas-scale of temperature. The only defect of the caloric theory lay in the tacit assumption, so easily rectified, that the ordinary calorimetric units were units of caloric. The quantity measured in an ordinary calorimetric experiment is the motive power or energy of the caloric, and not the caloric itself. If this had been realised in 1850, it would have been quite unnecessary to recast and revolutionise the entire theory of heat. Evolution might have proceeded along safer lines, with the retention of caloric, and the investigation of its properties, which are of such fundamental importance in all questions of equilibrium in physics.

Since Carnot's equation, $dW/dt=QF'(t)$, was adopted without material modification into the mechanical theory, and $QF'(t)$ remained simply a quantity of Carnot's caloric (though Q was measured in energy units and $F'(t)$ received the appropriate value J/T required to reduce energy units to caloric), it was inevitable that Carnot's caloric should make its reappearance sooner or later in the mechanical theory. It first reappears, disguised as a triple integral, in Kelvin's solution (*Phil. Mag.*, iv., p. 305, 1852) of the problem of finding the available work in an unequally heated body. The solution (as corrected later) is equivalent to the statement that the total quantity of caloric remains constant when the equalisation of temperature is effected reversibly. Caloric reappeared next as the "thermodynamic function" of Rankine, and the "equivalence-value of a transformation" (Clausius, *Pogg. Ann.*, 93, p. 487, 1854). Finally, in 1865, when its importance was more fully recognised, Clausius (*Pogg. Ann.*, 125, p. 390) gave it the name of "entropy," and defined it as the integral of dQ/T. Such a definition appeals to the mathematician only. In justice to Carnot, it should be called caloric, and defined directly by his equation $W = AQ(T - T_0)$, which any schoolboy could understand. Even the mathematician would gain by thinking of caloric as a fluid, like electricity, capable of being generated by friction or other irreversible processes. Conduction of caloric is closely associated with the electrons, and the science of heat would gain, like the science of electricity, by attaching a more material conception to the true measure of a quantity of heat, as distinguished from a quantity of thermal energy.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An exhibition of 50*l.* a year, tenable for two years, is offered by the governing body of Emmanuel College to an advanced student commencing residence at Cambridge as a member of Emmanuel College in October. The exhibition will be awarded at the beginning of October.

The Day Training College will be known in future by the title of "The Cambridge University Training College for Schoolmasters." This change is made to meet a suggestion from the Board of Education.

The subject selected for the Adams prize in 1912 is "The Theory of Radiation." The experimental scrutiny of the spectra of gaseous substances has amassed much knowledge, already expressed in semi-empirical formulæ, relating to the structure of spectra, whether composed of discrete lines or of bands, and also relating to the influence of various physical causes, such as the admixture of other substances, on the relative intensities of the lines. The nature of the magnetic influence on lines and bands which is exhibited in the Zeeman effect awaits closer investigation, and the classification of the lines of a spectrum which it suggests may afford further clues towards the assembling of those groups of lines which are possibly in some way components of one fundamental mode of vibration. A critical discussion of some of the problems of molecular dynamics which are associated with these phenomena is proposed. This discussion might proceed either from some hypothesis of structure of the molecules of matter, or from comparison, by way of analogy, with the properties of known types of vibrations. Questions relating to the constitution of natural radiant energy in statistical equilibrium might also come up for consideration. The prize is open to the competition of all persons who have at any time been admitted to a degree in this University. The essays must be sent to the Vice-Chancellor on or before the last day of December, 1912.

The first lists of candidates for the tripos examinations next term have just been issued. The numbers of names are as follows:—mathematical tripos, part i., 127, part ii., 53; classical tripos, part i., 108, part ii., 9; law tripos, part i., 60, part ii. and for LL.B. degree, 75; history tripos, part i., 129, part ii., 108; theological tripos, part i., 38, part ii., 17; natural sciences tripos, part i., 223, part ii., 44; mechanical sciences tripos, 46; moral sciences tripos, part i., 7, part ii., 1; mediæval and modern languages tripos, 55; Oriental languages tripos, 5; economics tripos, part i., 18, part ii., 16.

LONDON.—A revised syllabus in physics for the B.Sc. pass examination for internal students has been approved to come into force in 1912. Internal students will in future be required to satisfy the examiners in the practical as well as in the written part of an examination in a science subject.

Dr. A. D. Waller, F.R.S., has been appointed as a representative of the University on the governing body of the Imperial College of Science and Technology to fill the vacancy created by the resignation of the Right Hon. Sir Henry Roscoe, F.R.S.

A memorial from the Deptford Borough Council has been presented to the Senate asking that immediate steps be taken with a view to the establishment at Goldsmiths' College of a University College for South London with low fees, available for day and evening students.

The D.Sc. in geology has been granted to Arthur Wilmore, an external student, and the D.Sc. degree in chemistry has been granted to Arthur Clayton, an internal student of the Royal College of Science.

The second annual report of the Military Education Committee, which has been presented to the Senate, shows that the University contingent of Officers Training Corps has made good progress during the year. The strength on December 31, 1910, was 33 officers and 953 cadets, and an artillery unit armed with two 18-pounder field guns has been formed during the year. A list of eleven cadets who have proceeded to commissions in the Special Reserve, or Territorial Force, is included in the report.

A university studentship in physiology of the value of 50*l.* is open. Applications must be received by the principal on or before May 31.

OXFORD.—On March 7 Congregation took into consideration a further amendment to the "Faculties" statute, which would have had the effect of exempting the lectures given by professors and readers in the University from the control of their respective boards of faculty. The amendment was approved by several of the professors, but opposed by others, including Prof. Gotch, professor of physiology. On a division it was lost by 32 to 66. This will have the effect of giving power to the boards of faculty to exclude the lectures of professors and readers from the official list of lectures.

PROF. DAVID A. MOLITOR has resigned the chair of topographic and geodetic engineering at Cornell University, which he has held since 1908. He is returning to private engineering practice in the West.

THERE is about to be tried an interesting experiment in academic cooperation between North and South America. At the suggestion of the University of La Plata, Buenos Aires, Prof. W. J. Hussey is to spend six months of the year in the service of that University and six months at the University of Michigan, where he has occupied the chair of astronomy and held the directorship of the observatory since 1905.

WE learn from *Science* that the State appropriation for the Massachusetts Institute of Technology is to be increased. There is to be paid annually, for ten years, to the institute the sum of 20,000*l.*, from January 1, 1912, to be expended under the direction of the corporation for the general purposes of the institute; the institute will maintain forty free scholarships in addition to those maintained already. From the same source we find that Mr. Carnegie recently wrote to the trustees of the Carnegie Institute at Pittsburg that he is prepared to increase the endowment income 10,000*l.* or 20,000*l.* a year if it can be shown that any department is hampered from lack of funds. An old student, who wishes to remain anonymous, has given, our contemporary states, to Phillips Exeter Academy 3555*l.*, with which to complete the Wentworth mathematical fund of 10,000*l.*

THE Army Council has made a number of decisions regarding the regulations for admission to the Royal Military Academy and the Royal Military College, and those under which commissions in the Regular Army may be obtained through other channels of entry. The lower limit of age at which candidates are permitted to compete for admission to the Royal Military Academy will next November be reduced to 16½ years, and that at the Royal Military College will in June, 1912, be reduced from 17½ to 17 years. Eventually the upper limit of age for admission at both colleges will be 19 years. After March, 1912, no further examinations will be held by the Army Qualifying Board. The leaving certificate for Army purposes has been redefined, and for the future is to be a certificate which testifies to a certain standard of proficiency in the subjects stated, and is granted by certain bodies to candidates not less than 16 years of age who have attended a course of study at a school approved by the Army Council. For the future, a certain number of cadetships at the Royal Military College will be reserved each half-year for the nomination by the Army Council of suitable candidates at recognised schools. To be recognised by the Council, a school must be inspected by an approved educational body and reported as fulfilling the necessary educational requirements, and maintain a contingent of the Officers Training Corps. A certain number of prize cadetships is to be awarded to successful competitors at each half-yearly examination for admission to the Royal Military Academy and Royal Military College with the view of encouraging a higher standard of education among candidates for commissions in the Army, and of reducing in the case of the better qualified candidates the expenses incurred.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—Sir Archibald Geikie, K.C.B., president, in the chair.—Prof. P. V. **Bevan**: The absorption spectra of lithium and cæsium. This paper gives an account of the continuation of work done on the absorption spectra of vapours of the alkali metals. Difficulty was found in obtaining tubes which were not acted on by lithium vapour, and this difficulty was never completely surmounted. By the use, however, of considerable quantity of lithium in a steel tube, the absorption spectrum was obtained, and twenty-seven lines of the principal series were observed. The measurements for the whole series are given in the paper, the lines from the tenth to the twenty-seventh being new. The paper further gives measurements of wave-lengths for the similar lines for cæsium. The series has been extended to include twenty-four lines, and re-measurements were made, as there was pointed out by Prof. Hicks some probable errors in former determinations. The two series for lithium and cæsium are compared with the formulæ suggested by Hicks, and it is found that the agreement of calculated and observed wave-lengths is exceedingly good, a slight change in one of the constants for cæsium being indicated.—Prof. P. V. **Bevan**: Dispersion in vapours of the alkali metals. This paper gives an account of measurements of the dispersion in rubidium and sodium vapours. The work is of the same character as that on the dispersion in potassium vapour described in the Proceedings of the Royal Society, A, 84, 1910. Dispersion curves for the rubidium vapour were obtained for the region of wave-lengths 6000 to 3000. Anomalous dispersion effects were observable at the first eight members of the principal series lines. These lines being pairs, interesting curves are obtained for the second and third pairs. The relative values of the constants in the Maxwell-Sellmeier formula are obtained, and similar conclusions drawn from them, as in the case of the paper already referred to concerning the numbers of atoms taking part in the absorption of light. Measurements of wave-lengths of the lines of the principal series are given, and these are shown to be in good agreement with the values calculated from the Hicks modification of the Rydberg formula. Similar measurements were made in the case of sodium. In this case the effects are not so large or so easily obtainable as in the cases of rubidium and potassium. Measurements were also made to see if any temperature effect could be detected in the ratios of the constants of the dispersion formula. These go to show that the ratios m_1/m_2, m_2/m_3, &c., where m_1/m_2, &c., are the constants corresponding to the first, second, &c., lines of the principal series, increase with increase of temperature. This result is what might be expected if the absorbing atoms are ordinary atoms to which corpuscles become attached, more complex systems corresponding to higher members of the series of lines in the spectrum.—J. **Kendall**: The ionic solubility-product. Previous investigations upon the simultaneous solubility in water of two substances containing a common ion have been confined to those cases in which the substances examined have been of the same type—*i.e.* either both strong or both weak electrolytes. In each case the experimental results have been considered to be consistent with the hypothesis of a constant ionic solubility-product, although, even in dilute solutions, the agreement is only approximate. The primary object of this research was to test the applicability of the theory to substances of opposite types, one strong and one weak electrolyte. Preliminary experiments showed that here also small divergencies were obtained. Finally, a series of experiments on all the possible types of combination of two electrolytes was carried out, first with dilute and afterwards with more concentrated solutions, in order to ascertain the cause of these divergencies and their bearing upon the solidity of the theory. The results obtained show that the mutual solvent actions of the two substances play an important part in the equilibrium. The general rule appears to be that two substances chemically similar in character give results in excess of theoretical, while with two chemically dissimilar a diminution is observed. In dilute solutions all divergencies are small, but fundamental, and in certain cases the amount due to each of the two substances is calculated. In the more concentrated solutions, where the solvent effect is greater, the three possible types of solubility curves are obtained and discussed, and it is found that in all cases experimental divergencies from values indicated by the constant solubility-product hypothesis can be fully accounted for by this solvent effect of the substances upon each other.—Dr. W. H. **Eccles** and H. **Morris-Airey**: Note on the electrical waves occurring in nature. The occurrence of a lightning stroke must, in general, give rise to either a solitary electric wave or a train of electric waves which will be propagated from the centre of discharge to unknown distances. These vagrant waves join with other natural electric phenomena to cause disturbances—technically called "atmospherics"—in the receiving circuits of wireless telegraph stations. Among these other phenomena may be mentioned charged hail or rain striking the air-wires and earth-air currents. The present communication describes an endeavour to determine the proportion of atmospherics of distant origin. The plan of attack was as follows:—One of the authors in London and the other in Newcastle arranged receiving apparatus just as for the telephonic reception of signals, and simultaneously listened, at prearranged times, for atmospherics. A hand record of the time and intensity of each strong atmospheric was made on paper ruled to represent ten seconds of time per inch. By arranging the periods of observation to include the midnight time signals from the Eiffel Tower or from Norddeich, the time records of the two observers could be accurately coordinated. The observers exchanged copies of their records, and counted the number of marks coinciding in time. The results tend to show that about 70 per cent. of the atmospherics audible at two stations 270 miles apart are due to vagrant waves propagated from electrical discharges that take place at (possibly) very great distances.—Prof. E. A. **Schäfer** and K. **Mackenzie**: The Action of animal extracts on milk secretion.

Linnean Society, March 2.—Dr. D. H. Scott, F.R.S., president, in the chair.—Dr. **Burr**: Dermaptera (earwigs) preserved in amber.—Miss Laura Roscoe **Thornely**: Report on the marine Polyzoa of the collection made by Mr. J. Stanley Gardiner, in the Indian Ocean, in H.M.S. *Sealark* during 1905.—W. M. **Tattersall**: The Mysidacea and Euphausiacea collected in the Indian Ocean during 1905.

Royal Anthropological Institute, March 7.—Prof. Gowland, F.R.S., in the chair.—Dr. **Duckworth**: Cave exploration at Gibraltar in September, 1910. The object of this research was to gain information on the spot as to the exact conditions in which prehistoric human remains occur on the Rock of Gibraltar. In addition to a general survey of the locality, two caves were explored. The first cave examined is in Forbes Quarry, whence the human cranium, so well known as the Gibraltar skull, was obtained in 1848. The cave in question proved very difficult to work, owing to the great density of ten successive stalagmite strata composing its floor. The latter was exposed over a considerable area, and at a depth of 4 feet 6 inches solid rock was always present. No animal remains could be detected. Since this excavation, Forbes Quarry has been almost completely filled, owing to the fall of many tons of rock from the heights above. The mouth of the cave is now hardly accessible. The second cave was at a considerable height (800 feet) above sea-level. The excavation yielded abundant evidence that it had been a resort of prehistoric man in the early Neolithic stage of culture. The conditions are best explained by describing them as a cave kitchen-midden. The evidence of human occupation includes the larger part of a human skeleton of the Cro. Magnon type, in addition to stone implements, sherds, and shell ornaments. The associated fauna is varied. To the list of such animals as have been recorded already, the following can now be added, viz.:—wolf, seal (Monachus), and almost certainly chamois, with certain birds and reptiles. Special attention was given to the identification of small mammalian bones with the view of ascertaining the presence or absence of Arctic rodent types; the latter were not identified. The author intends to seek further permission from the authorities to continue these researches at an early date.

Mathematical Society, March 9.—Dr. H. F. Baker, president, in the chair.—Prof. G. B. **Mathews**: The reduction and classification of binary cubic forms which have a negative determinant.—Major P. A. **Macmahon**: The theory of partitions.—Prof. A. E. H. **Love**: The theory of the transmission of earthquake waves.

CAMBRIDGE.

Philosophical Society, February 20.—Sir George Darwin, K.C.B., F.R.S., president, in the chair.—Prof. **Nuttall**: The adaptation of ticks to the habits of their host. A survey of the present knowledge of the structure and biology of the Ixodoidea. The views expressed may prove of practical use in the study of the Ixodidæ.—Dr. **Cobbett** and Dr. **Graham-Smith**: The entry of bacteria into the lungs. Experiments made by the authors showed that, if *B. prodigiosus* be placed in the mouths of very young guinea-pigs, these micro-organisms may be found in the lungs a few minutes afterwards. The authors believe that the results obtained give the true explanation of the appearance of tuberculosis in the lungs of animals fed with tubercle bacilli in many experiments, and that they invalidate conclusions which have been drawn from such experiments as to the usual path of infection in pulmonary tuberculosis.—F. **Ransom**: The action of caffeine on muscle.—W. E. **Dixon**: Toleration to nicotine. One form of toleration to chemical substances is associated with their destruction and oxidation; the tolerance to alcohol and morphine are examples. In the case of nicotine, it has been found that normal animal tissues have the power to destroy a small quantity of the alkaloid. The tissues of animals which have been rendered tolerant to nicotine destroy a considerably larger amount. There is evidence to show that the destruction of the nicotine is not due to a chemical combination with the tissues, but that, on the contrary, it is brought about by ferment action.—Dr. **Cow**: The action of pituitary extract and adrenalin on peripheral arteries. Employing the method of O. B. Meyer, adrenalin constricted the peripheral arteries with the exception of the intravisceral portion of the pulmonary, the coronary, and cerebral arteries. The coronary and cerebral vessels were dilated, and the intravisceral portion of the pulmonary was unaffected. Pituitrin produced dilatation of the splenic, hepatic, and gastric arteries except along the first 3 or 4 mm. after their origin from the cœliac axis, in which part constriction was produced.—W. M. **Scott**: The action of ultra-violet rays on blood sera. Experiments were described showing that exposure to ultra-violet light destroyed the protective properties of immune sera in greater measure than it diminished their anaphylactic toxicity, and was therefore not of practical value for serum therapeutics.—E. A. **Owen**: The scattering of X-rays. Experiments have been made on the distribution of scattered X-rays. With hard rays, the distribution on the incident and emergent sides of the radiator is found to be the same. With softer rays the intensity is greater on the emergent side. This dissymmetry increases with the softness of the primary beam. It is also found that the dissymmetry alters somewhat with the thickness of the radiator.

PARIS.

Academy of Sciences, March 6.—M. Armand Gautier in the chair.—The president announced the death of van 't Hoff, correspondant in the section of mechanics, and gave a brief summary of his chief researches.—Armand **Gautier** and Charles **Moureu**: The examination of a new thermal water, presented as a prototype of a modern physico-chemical study of a mineral water. The methods of estimation of small quantities of lithium, manganese, antimony, bromine, fluorine, rare gases, &c. In addition to the ordinary physical properties, measurements of electrical conductivity, ionisation, and radio-activity were made. The radio-active emanation and the radium in the state of salt were estimated separately. Traces of antimony and tin were recognised in the chemical examination, and new methods are given for the determination of traces of lithium and fluorine.—A. **Haller** and Edouard **Bauer**: The action of ethyl chlorocarbonate on the sodium derivatives of ketones prepared by means of sodium amide. Isopropylphenylketone was converted into its sodium derivative by treatment with the theoretical quantity of sodium amide in presence of benzene; the slow addition of ethyl chlorocarbonate resulted in the formation, not of ethyl benzoyldimethylacetate, but of its enolic isomer. Other ketones of different types furnished similar products.—A. **Lacroix**: The radio-active minerals of Madagascar. A general description of the nature of these minerals and the conditions under which they are found. A detailed account of their analysis and radio-activity is reserved for a later paper. Complete analyses are given for samples of bloomstrandite, euxenite, samarskite, and fergusonite.—Ch. **Bouchard**: The toxic theory of sleep. Remarks on a recent paper on this subject by MM. Legendre and H. Piéron. The author notes that he published analogous experiments in 1886.—Edouard **Heckel**: A new plant from Madagascar giving aniseed oil. From the specimens examined, the author concludes that this plant is probably *Pelea madagascarica*. The parts of the plant examined contain from 4 to 5 per cent. of the essential oil, and the results of a physical and chemical examination of the oil are given.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1910. Observations were carried out on forty-seven days during the quarter. The results are given in tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Ch. **Galissot**: The selective absorption of the atmosphere. During 1909 and 1910 the author has repeated at the Observatory of Lyons the observations of Müller, using the Nordmann heterochrome photometer. Neither the observations of the author nor those of Müller can be represented on the usual hypothesis that the absorption depends only on the mass of air traversed.—Carl **Störmer**: The structure of the solar corona according to the Arrhenius theory.—D. **Eginitis**: Observations of the Faye-Cerulli comet made at the Observatory of Athens with the Gautier 50-cm. equatorial. Positions are given for December 3 and 23, and details of its appearance on those dates.—Robert **Jonckheere**: The discovery of new double stars at the Observatory of Hem.—Emile **Borel**: The structure of ensembles.—T. **Lalesco**: An integral equation of the Volterra type.—Louis **Roy**: The propagation of discontinuities in the motion of flexible wires.—J. **Paillet,** F. **Ducretet,** and E. **Roger**: A new method for the de-electrification of textile materials by means of high-frequency currents. Textile fibres during the processes of manufacture tend to become electrified. This causes separation of the fibres, leading to losses and deterioration of the product. The current methods of remedying this lead to the production of very moist and unhealthy atmospheres in the factory. The electrical method proposed by the authors is independent of the humidity and temperature, and gives better results in practice than can be obtained by the processes in ordinary use.—Pierre **Weiss**: An idea of Walther Ritz on band spectra. A discussion of some posthumous notes of Ritz.—F. **Leprince-Ringuet**: Formulæ relating to the transmission of heat between a fluid in motion and a metallic surface.—Ch. **Fery** and M. **Drecq**: The constant of radiation. A reply to some criticisms of MM. Bauer and Moulin on the method of calibration adopted in an earlier paper, and a description of a repetition of the experiments, with some modifications. The results completely confirm the determination published in 1909.—L. **Dunoyer**: The kinetic theory of gases and the realisation of a material radiation of thermal origin.—H. **Guilleminot**: The Sagnac radiations.—A. **Rosenstiehl**: Polymerised water and water of crystallisation. A reply to M. Lecocq de Boisbaudran.—J. **Boselli**: Reaction velocities in gas-liquid systems.—A. **Besson** and L. **Fournier**: The chlorobromides and chloroiodides of silicon. The chlorobromides of silicon can be obtained in a pure state by the simultaneous action of hydrogen and bromine upon silicon tetrachloride under the influence of the silent discharge. The new method has the advantage of ensuring the absence of oxychlorides.—M. **Nanty**: The action of potassium bicarbonate upon magnesium chloride and upon soluble salts of magnesium in general.—G. **Darzens** and H. **Rost**: Some derivatives of butylcyclohexane. An account of the application of the Sabatier and Senderens method of adding hydrogen to butylphenol and its homologues.—André **Meyer**: The azo derivatives of phenylisoxazolone.—J. **Beauverie**: The hypothesis of the mycoplasma and the metachromatic corpuscles.—Pierre **Lesage**: The use of potash solutions for the recognition of the germinative faculty of certain seeds. It is shown that seeds that have lost their germinative faculty impart a colour to potash solution of a certain strength, whilst seeds still capable of germinating do not colour such solutions. As a means of rapidly sorting seeds, the author thinks this test may possess certain advantages.—Henry **Pénau**: The cytology of *Bacillus anthracis*.—A. **Marie** and Léon **MacAuliffe**: Anomalies in the dimensions of the ears in the insane.—L. **Spillmann** and L. **Bruntz**: The effect of certain pathological processes on the action of the leucocytes.—H. **Stassano** and L. **Lematte**: The possibility of preventing intact the agglutinated masses in bacteria which have been killed by the ultra-violet rays. The advantages of this means of sterilisation for the preparation of bacterial emulsions designed for sero-diagnostic purposes.—Pierre **Lesne**: The variations of feeding in the Coleoptera.—F. **Mesnil** and M. **Caullery**: Papillomatous neoformations in an annelid (*Potamilla torelli*). A description of a growth recalling the papilloma in vertebrates.—Edouard **Chatton**: *Paramyxa paradoxa*, a cnidosporidium without cnidoblast.—Carl **Renz**: The existence of some new Triassic deposits in central Greece.—P. and N. **Bonnet**: The existence of the Trias and the Mesojurassic in the *massif* of Kasan-Ialla (southern Transcaucasia).—L. **Cayeux**: The middle Miocene in the island of Crete.—Léon **Bertrand**: The structure of the western Pyrenees.—Louis **Fabry**: The three earthquakes of February 18 and 19, 1911. A discussion of the records of the seismograph of the Observatory of Marseilles.—The president gave an account of the legacy left by M. A. T. Loutreuil to the Academy of Sciences. This legacy amounts to 3,500,000 francs, and the testator's wishes as to the administration and application of the fund are given in full.

DIARY OF SOCIETIES.

THURSDAY, MARCH 16.

ROYAL SOCIETY, at 4.30.—Gametogenesis of the Gallfly, *Neuroterus lenticularis*. Part II.: L. Doncaster.—The Action of the Venom of *Echis carinatus*: Sir T. R. Fraser, F.R.S., and Dr. J. A. Gunn.—Further Researches on the Development of *Trypanosoma gambiense* in *Glossina palpalis*: Colonel Sir D. Bruce, C.B., F.R.S., and others.—Spontaneous Cancer in Mice: Dr. M. Haaland.

ROYAL INSTITUTION, at 3.—Giants and Pygmies: Prof. A. Keith.

LINNEAN SOCIETY, at 8.—On the Brown Seaweeds of the Salt Marsh: Miss S. M. Baker.

ROYAL SOCIETY OF ARTS, at 4.30.—Education in India: C. H. A. Hill.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Presidential Address: E. B. Ellington.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Research Meeting. Names of the South Sea Islands: W. H. R. Rivers.—Geographical Monographs from Oxford. Salisbury District: L. M. Hardy.—Andover District: O. G. S. Crawford.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 9.—Water Supply: J. H. Balfour-Browne.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Production of Water-gas: Alwyne Meade.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Radiant Energy and Matter: Sir J. J. Thomson, F.R.S.

MONDAY, MARCH 20.

ROYAL SOCIETY OF ARTS, at 8.—Applications of Electric Heating: Prof. J. A. Fleming, F.R.S.

VICTORIA INSTITUTE, at 4.30.—Prof. Hilprecht's newly-discovered Deluge Fragment: Dr. T. G. Pinches.

TUESDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—Explorations of Ancient Desert Sites in Central Asia: Dr. M. A. Stein.

ZOOLOGICAL SOCIETY, at 8.30.—On the Amphipod Genus Leptocheirus: Mrs. E. W. Sexton.—On Colour and Colour-pattern Inheritance in Pigeons: J. Lewis Bonhote and F. W. Smalley.—Notes on Marine Ostracoda from Madeira: Dr. G. Stewardson Brady, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: The Electrification of a Portion of the Suburban System of the London, Brighton and South Coast Railway: P. Dawson.

ROYAL ANTHROPOLOGICAL SOCIETY, at 8.15.—Physical Characters of Bushmen Past and Present: Dr. F. C. Shrubsall.

ROYAL STATISTICAL SOCIETY, at 5.—Some Statistics of Japan: Charles V. Sale.

MINERALOGICAL SOCIETY, at 5.30.—On Mr. Solly's Observation of Wiltshireite in 1903: Prof. W. J. Lewis, F.R.S.—Two New Minerals from the Binnenthal: R. H. Solly.—Notes on Cassiterite in the Malay Peninsula: J. B. Scrivenor.—Notes on the Occurrence of Dundasite in Derbyshire and Co. Galway, and of Bertrandite in Cornwall: A. Russell.—On Quartz-twinning: Dr. J. Drugman.—Crystallographic Notes: T. V. Barker.

WEDNESDAY, MARCH 22.

ROYAL SOCIETY OF ARTS, at 8.—The Manufacture of Portland Cement: A. C. Davis.

GEOLOGICAL SOCIETY, at 8.—On some Mammalian Teeth from the Wealden of Hastings: Dr. A. Smith Woodward, F.R.S.—Some Observations on the Eastern Desert of Egypt; with Considerations bearing on the Origin of the British Trias: A. Wade.—Faunal Horizons in the Bristol Coalfield: H. Bolton.

THURSDAY, MARCH 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: A Theory of Asymptotic Series: G. N. Watson.—The Ionization of Heavy Gases by X-rays: R. T. Beatty.—The Variation of the Ionization with Velocity for the β Particles: W. Wilson.—The Causes of Absorption of Oxygen by the Lungs in Man: C. G. Douglas and Dr. J. S. Haldane, F.R.S.—The Influence of Planets on the Formation of Sun-spots: Dr. A. Schuster, F.R.S.

ROYAL INSTITUTION, at 3.—Giants and Pygmies: Prof. A. Keith.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electricity Meters with Notes on Meter Testing: H. A. Ratcliff and A. E. Moore.

FRIDAY, MARCH 24.

ROYAL INSTITUTION, at 9.—The Sidereal Universe: Sir David Gill, K.C.B., F.R.S.

PHYSICAL SOCIETY, at 5.—(1) A Sensitive Thermo Regulator; (2) Experiments on the Measurement of Electrolytic Resistances using Alternating Currents: Dr. H. F. Haworth.—(1) Oscillatory Currents in Coupled Circuits; (2) Some Radio-telegraphic Apparatus in Use at the City and Guilds (Engineering) College: Prof. G. W. O. Howe.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Uses of Chemistry in Engineering: James Swinburne, F.R.S.

SATURDAY, MARCH 25.

ROYAL INSTITUTION, at 3.—Radiant Energy and Matter: Sir J. J. Thomson, F.R.S.

CONTENTS.