THURSDAY, APRIL 4, 1907.

CHEMICAL CRYSTALLOGRAPHY.

Chemische Krystallographie. By P. Groth. Erster Teil. Pp. viii+626. (Leipzig: W. Engelmann, 1906.) Price 20 marks.

THE appearance of the first volume of this monumental work by Prof. P. von Groth marks an epoch in the history of crystallography. Ever since it was known that the famous editor of the *Zeitschrift für Krystallographie* had such a work in progress, expectancy has been of the keenest in the mineralogical and crystallographical world. That the book would be worthy of the man was felt to be assured, and the event has fully justified such confidence. It is to be published in four volumes, and if the other three are equal to the first now before us, the whole will form a compendium of crystallographic knowledge which for completeness, detail, and accuracy will stand unique. The work will include practically the whole of our crystallographic knowledge concerning every crystallised substance yet described.

There can be no doubt that Prof. von Groth is particularly marked out by circumstances for the compilation of such a *magnum opus*. For not only has he edited the *Zeitschrift für Krystallographie* since its inception by him thirty years ago, but he has exhibited from time to time, especially by the rapid succession of new editions of his standard text-book, "Physikalische Krystallographie," and his smaller but not less interesting "Einleitung in der chemische Krystallographie," a remarkable gift of assimilating, weighing, collating, and presenting in readable and indeed highly interesting form the chief advances in crystallography as they occur. His most careful personal editorship of every paper of importance which is published in the *Zeitschrift* has rendered him familiar with these advances in all their details. Moreover, his reputation as a teacher has made his laboratory at Munich the resort of as earnest and enthusiastic a class of students as is to be found anywhere. Hence this book will be received by all those interested in crystallography with a quite unusually warm welcome, deeply tinged with reverence, partly on account of the excellence of the material which the book itself contains, but in even greater measure because of the respect with which every word uttered by the great master and universally acknowledged *doyen* of his subject is received.

In Britain the book will meet with an exceptionally cordial reception from the small band of our native crystallographers, who have ever been treated by Prof. von Groth with particular kindliness, and have received from him the strongest encouragement, and never more so than at times when it has unfortunately been only too evident that the study of crystals was not appreciated in this country. The writer of this review can never forget the more than kind encouragement extended to him by Prof. von Groth during the earlier stages of the organised series of researches which the writer inaugurated in the year 1891 on the alkali sulphates and selenates and their double salts, and which had for their first object the introduction of greater accuracy into crystallographic methods. Prof. von Groth has frequently expressed the wish that the country of Miller, the father of modern crystallography, should take a much greater part in the advance of crystallography than she was doing some fifteen years ago. Now, however, at last the small band of British workers, partly from the stimulating influence of such encouragement, has been able to make some impression, and not only mineralogists, who have alone in the past appreciated crystallography at its true value, but chemists, to whom its intrinsic value is immeasurable, as well as metallurgists and physicists, are awakening to the fact that the study of crystals is the study of solid matter in its highest, most perfectly organised form, and that it is likely to lead to the most important fundamental truths. Already the researches just alluded to have afforded a final and irrefragable proof of the accuracy of Haüy's original conception that to every definite chemical substance there appertains a distinct and characteristic crystalline form, and have reconciled this with Mitscherlich's discoveries in isomorphism by revealing an exquisitely beautiful relationship, connecting very small angular differences which are found to occur between the crystals of the various members of isomorphous series with the atomic weight of the interchangeable elements composing them. This generalisation not only defines the real meaning, extent, and scope of Mitscherlich's law, but also proves that the supposed exceptions are not such, and, therefore, the absolute truth of the rule that difference of chemical composition does in all cases involve difference of crystalline form.

That the subject to the advance of which Prof. von Groth has devoted himself is indeed of the intrinsic importance which the writer has recently claimed for it, in a couple of articles in the engineering supplement of the *Times*, is strikingly demonstrated by the fact that the very groundwork of chemistry, the law of valency, has been shown in a remarkable paper by Prof. Pope and Mr. Barlow, read recently to a crowded audience at the Chemical Society, to be clearly connected with, if not dependent upon, the internal structure of crystals. This most interesting theory carries the conception of "topic axes," which express the relative structural dimensions of the crystals of isomorphous series, and which were introduced simultaneously by Dr. (now Prof.) Muthmann, one of Prof. von Groth's pupils and assistants, and the writer in the year 1894, a step further so as to include no longer merely the members of isomorphous series, but also substances of the most diverse characters; and whatever may be the fate of this theory, it can no longer be doubted that crystallography must play a much more important *rôle* among the subjects of science in the future than it has played in the past.

The present juncture, therefore, is a most opportune one for the appearance of Prof. von Groth's great book. It will be invaluable to all crystallographical investigators, and particularly so as an excellent bibliography of all the important investigations up to date

is included, concerning every substance discussed. This first volume deals with the solid elements, with the inorganic compounds of a non-saline character, such as oxides, sulphides, and phosphides, and with the halogen salts, cyanides and salts of the recently discovered nitrogen acids. The second volume is to deal with the inorganic oxy- and sulpho-salts and the remaining inorganic crystalline compounds, while the third and fourth volumes are to treat of the organic compounds. The arrangement of the text is that each group is described, as regards its general characteristics, in an introductory statement in large type, and this is then followed by the detailed description of each member of the group in smaller type.

An excellent *résumé* of the crystallography of the naturally occurring minerals is given, but it is the detailed crystallography of the substances requiring to be prepared chemically, and the descriptions of which cannot be found elsewhere except by reference to the widely scattered original memoirs, that renders the book so priceless, for it presents the essential results of all chemico-crystallographical investigations right up to date. The illustrative figures of crystals are neat and clear, and the text easy, the large type even luxurious, to read.

One important feature has been left to the last to refer to, namely, that the symmetry of the crystals of each substance dealt with is given in accordance with the much more scientific method of classification recently adopted as the outcome of the completion by Schönflies, Fedorow, and Barlow of the geometrical theory of homogeneous structures, which enables the particular individual class represented in the substance under discussion to be at once identified from among the thirty-two possible classes of crystal symmetry.

In conclusion, with regard to the contents of this book, the best of all possible praise can conscientiously be bestowed in saying that it is worthy of the master-mind that conceived it.

A. E. H. TUTTON.

A NEW WORK ON ORGANIC EVOLUTION.

The Analysis of Racial Descent in Animals. By T. H. Montgomery, jun. Pp. xi+311. (New York: Henry Holt and Company; London: George Bell and Sons, 1906.) Price 10*s.* 6*d.* net.

IT would be a most fascinating task to trace the evolution of modern methods of dealing with the problems of life. Differentiation has taken place so extraordinarily quickly. The time is long past when one man can attempt to grapple with the whole problem. Not only so, but the time seems to be past when one man can even be interested in the whole problem. Evolutionists may be broadly classified into those to whom the problem of evolution is the problem of the origin of species and those to whom it is the problem of adaptation. The key-note of de Vries's "Mutationstheorie" is the solution of the problem of species; we even go so far as to say that this is the achievement of de Vries's work. The logical conclusion, the complete working out of the theory of natural selection, is reached in Dr. Archdall Reid's "Principles of Heredity." The interest of the two authors is entirely different. De Vries's interest is in the origin of species, Dr. Reid's in natural selection. Darwin's interest was in both; if we look no further than the title of his chief work we can see this—"On the Origin of Species by Means of Natural Selection."

The fact that these two interests have segregated, and the way in which they have segregated, are both very suggestive, and the direction in which they point is the same. The fact of segregation suggests that the association of the two ideas was unnatural, and that they were not capable of union. The way in which they have segregated confirms this suspicion. For those who devote their attention to the question of species reject natural selection, while those who elaborate the theory of natural selection find no support in the phenomenon of specific difference. All possibility of a reconcilement between the divorced ideas is put an end to by Meyrick, who probably knows more about specific difference than anyone else. In his handbook of British Lepidoptera he says that, in seeking for the most suitable characters by which species may be distinguished, those which can in any way be regarded as useful to the species must be discarded without more ado.

It is not surprising that Darwin's work should have borne fruit which segregated in this way. The case is thoroughly Mendelian. Darwin's work was a cross between a biological theory of evolution and a social and industrial theory of competition. The hybrid, more vigorous than either parent, took the world by storm. We are now witnessing its posterity separating out more or less simply into the two forms which were united in the beginning. Just as every plant in the F_1 generation contains yellow and green peas, and just as it is not until the next that there can be found plants bearing only yellows or only greens, so Darwin's interest was in the "Origin of Species by Natural Selection," while now we find de Vries, who is absorbed entirely with the former, and Reid entirely with the latter.

The immediate result of Darwin's work was the flood of energy which spent itself in tracing out the genealogical histories of organisms. To such lengths did the students of phylogeny go, so remote from reality did their speculations become, that the study of phylogeny has fallen into discredit in the eyes of a great many of those who are looked up to as biological thinkers to-day.

Prof. Montgomery's interest is centred neither in species nor in selection, but in phylogeny. He admits that phylogeny has been discredited by the indiscretion and shallowness of a number of its exponents, but he contends that if we limit ourselves to the strictly experimental method we are neglecting an enormous range of phenomena.

"For living organisms are in number and variety hardly commensurate with the vast assemblage of their ancestors. Are we then to leave out of consideration all this once existing life, simply because

its units are no longer subject to experiment? Most assuredly not."

Our author undertakes the herculean task, we venture to think successfully, of setting the study of phylogeny on a surer foundation. The reason that phylogenetic inquiry has become discredited is that the majority of biologists are neither so stupid that they are content to dabble with phylogeny nor clever enough to make it a great and fruitful sphere of inquiry—a field fit for the exercise of the highest intelligence.

The experimental method has its limitations no less than its fascination. It is not merely a paradox to say that in biology those things with which we can experiment most are those which to the organism matter least. The reason is that we are not the first to start experimenting. Nature has been there before. For example, the range of continuous variation in an organism may either be the direct result of the constitution of the living substance or it may have been determined by the most stringent selection acting since life dawned. If, therefore, we institute experiments on variation—for example, the determination of the effect of heat on the range of variation—we may either be studying one of the simple properties of protoplasm or discovering the limits within which natural selection allows the particular organism dealt with to vary under the conditions of heat, *e.g.*, to which we subject it. The really fundamental processes do not lend themselves to experiment. That is how they have become fundamental. Everyone who wishes to train himself to study them should read Prof. Montgomery's book.

There are a few trifling misprints, *e.g.* "embryoning" in the table of contents; and Mendel worked, not with the sweet, but with the culinary pea.

A. D. D.

ELECTRIC RAILWAYS.

Electric Railway Engineering. By H. F. Parshall and H. M. Hobart. Pp. xxiv+475. (London: Archibald Constable and Co., Ltd., 1907.) Price 42*s.* net.

THE authors of this work have already introduced a series of technical works upon dynamo design and kindred subjects, and Mr. Hobart is also known as the author of a recent work upon the steam turbine.

In the present volume the authors deal with a wider range of subjects, and, in short, treat of the whole question of heavy "electric traction," that is, traction as applied to railways rather than to street tramways. Such a book was required, and will be welcomed by the growing class of engineers who wish to add to their experience of steam railway work some knowledge of electrical engineering, which is more and more coming to invade the field of traction.

Technical works of this kind may, as a rule, be divided into two classes; on the one hand are the highly technical works which deal with the more scientific aspects of the subject, and of which the authors' "Dynamo Design" is an example; on the other are the entirely practical works which, at their worst, degenerate into collections of specifications. The present volume endeavours, not unsuccessfully, to combine these two, and to give the reader a clear knowledge of the fundamental principles that underlie the application of electricity to haulage, illustrations of the methods employed in carrying this into effect, and actual examples and details of construction. What it does not fully supply, and what, unfortunately, books of this kind very seldom contain, are the commercial results obtained from the adoption of electric traction. It may be said that this is outside the scope of an engineering treatise; and if the work is to comprise engineering in the sense in which that word was commonly used during the last century the answer is justified, for the engineer of those days was concerned with the question of "will it work?" rather than the question of "will it pay?" But the engineer of the twentieth century has become more and more obliged to look upon the latter as the test of successful engineering, and until a book can be produced dealing with electric traction from the operating point of view such works will not, it is to be feared, have much effect in influencing railway authorities to replace steam haulage by electric traction. Apart from these limitations, however, the present volume is most valuable, for although a considerable portion of the matter has been already published in one form or another, there was a great need for bringing together all that has been done and written.

The choice of the system to be adopted upon any particular part of a railway, although necessarily influenced by first cost, should ultimately be dependent upon its suitability for use upon the railway as a whole, and the results obtained from electrification must be judged in reference to the whole railway undertaking rather than in connection with one section. In connection with the vexed question of the relative advantages of direct current, single phase or three phase, the authors do not undertake to predict the form that the ultimate electric railway installation will assume, contenting themselves with pointing out the merits of each, and emphasising the fact that standardisation has been one of the great elements of success in steam railway working, and that the adoption of electric traction upon railways in the future will be slow until standardisation is adopted.

Coming now to the contents of the book itself, it consists of three parts, dealing respectively with the mechanics of electric traction, the generation and transmission of the electrical energy, and the rolling stock. Chapter i. deals with "tractive resistance at constant speed," and gives the results of applying both theoretical and arbitrary formulæ to the result obtained in actual practice.

Chapter ii. deals in a similar manner with the problem of acceleration. Many useful curves of acceleration, speed-time, and speed-distance are given. Chapter iii. deals with tractive force in relation to acceleration, while chapter iv. deals with the

characteristics of railway motors, upon the design of which Mr. Hobart is an acknowledged authority. Throughout the whole of this section a liberal use is made of graphical methods, and a number of curves referring to the energy consumption under different conditions in actual practice is given.

Chapter v. deals with the generating plant, and is, in our opinion, so far as the practical value of the information contained is concerned, scarcely so useful as the rest of the book; considerable space is devoted to descriptions of tramway generating stations, which, however up to date at the time of construction, are hardly representative of the most modern practice. The question of power-station design is a subject of its own, and is not one upon which the railway engineer, pure and simple, is often called upon to express an opinion. A design is given, however, of a proposed 10,000-kilowatt station, but, so far as can be judged from the drawing, the "complete unit" system by which, for safety reasons, the plant and buildings are entirely subdivided does not appear to be recommended. Interesting tables of the comparative cost and annual over-all efficiencies of various generating stations are given.

A chapter upon the transmission of the electrical energy calls for no particular comment; sections of the cables adopted on various railway systems and the sizes of such cables are given. Particulars are also given of the cost of these cables, but the value of this is, of course, greatly dependent upon the price of copper. Substations are next dealt with, details being given of a very large number of actual substations used in railway work.

Chapter viii., dealing with the distributing system, in other words the third rail, is of more interest, and contains a number of tables dealing with recent practice in this connection; overhead work is also illustrated, though not so fully as could be wished.

Part iii. deals with rolling-stock, and is replete with illustrations and working drawings of locomotives and carriages. This portion of the book, however, shows signs of haste in editing, and in future editions we would suggest that the efficiency curves of motors which it contains, and, in fact, the reference to motors generally, should be gathered together in one section, namely, chapter iv., where most of them are already to be found, instead of being again dealt with under locomotives; certain of the data of rolling-stock given in chapter iv. would, in our opinion, be more easily found in the chapter which is specially devoted to that branch.

These are, however, minor criticisms. The work is one of great practical value to all railway engineers, and will be further enhanced if in future editions more actual illustrations of the total costs of operation of electrified steam railways can be furnished. The North-Eastern Railway, the Lancashire and Yorkshire, and the District Railways have all been in operation long enough to furnish data of the greatest commercial value.

The general "get up" of the work is excellent, as are the reproductions of the various drawings.

OUR BOOK SHELF.

L'Année technique, 1906. By A. Da Cunha. Pp. xii+237; illustrated. (Paris: Gauthier-Villars, 1906.) Price 3.50 francs.

SINCE 1901 the author has each year prepared in attractive form a concise summary of recent progress in engineering, and his series of volumes cannot fail to prove of inestimable value to the student of French industrial history. His annual summary is not a mere compilation of disconnected notes, but a collection of essays written with originality, technical knowledge, and literary skill.

The subjects dealt with in the record for 1906 comprise accidents in works, the heating and water-supply of houses, public works, and locomotion. A museum illustrating the prevention of accidents in works having recently been inaugurated at the Conservatoire National des Arts et Métiers, Paris, the author has seized the opportunity of dealing at some length with the subject of industrial hygiene, and describes the museums that have been established with the object of bringing to public notice the arrangements that have been found by experience adapted for the protection of workmen in various industries. Museums of this kind exist at Zurich, Amsterdam, Vienna, Munich, Berlin, and Paris. The problem of efficaciously heating dwelling-houses is one that has long been under consideration. The old French fireplace, in which, it has been said, the hottest place is at the roof, has been superseded by modern fireplaces, by fixed or movable stoves, and by heating with steam or hot water.

Many ingenious improvements are described by the author, who also gives some useful advice on this important topic. Other interesting subjects dealt with include the installation of the huge compressed-air caissons for the passage of the Paris Metropolitan Railway under the Seine, the recent developments in automobile transport, and locomotion on ice and snow. The numerous illustrations have been carefully chosen and well executed, and the volume is produced in an attractive style at a modest price. Mr. Alfred Picard contributes a preface, which, like the rest of the volume, may be studied with profit and pleasure, not only by the engineer, but also by the general reader desirous of acquainting himself with the events of the day.

Diseases of Fruit and Fruit-bearing Plants. (Board of Agriculture and Fisheries.) Seven diagrams and text. (London: Printed for H.M. Stationery Office by Darling and Son.)

THE Board of Agriculture and Fisheries has issued a series of seven small coloured diagrams illustrative of a number of common diseases met with in cultivated plants, especially those which are grown for the sake of their fruit. They are adapted for use in schools in the country districts. They illustrate the general appearance of the diseased fruits, without any botanical details. Indications are given as to the best methods of prevention. The use of Bordeaux mixture is frequently and judiciously recommended, but no instructions are given as to the way in which the mixture should be prepared. It is certain that, in spite of the publicity which has been given to this excellent fungicide, many cultivators do not yet know how to prepare it. The use of liver of sulphur is also recommended, but the caution is not added that it should not be allowed to come in contact with the paint on frame or greenhouse so as to prevent the discoloration that would otherwise ensue.

No attempt is made to indicate the degree of injury inflicted by various fungi; thus the first of the series, the "strawberry leaf-spot," is of very little conse-

quence as compared with No. 2, the strawberry mildew. The now famous American gooseberry disease is illustrated. To prevent its spread, the use of one ounce of potassium sulphide dissolved in three gallons of water is recommended. With this solution the bushes should be sprayed just before the leaves expand, and the spraying should be repeated at intervals as necessary. It is unfortunate, we think, that the destruction of affected bushes by fire is not also recommended. A descriptive pamphlet, for which one penny is asked, is supplied with the diagrams.

La Mécanique des Phénomènes fondée sur les Analogies. By M. M. Petrovitch (Belgrade). "Scientia" Phys.-Math. Series, No. 27. Pp. 96. (Paris: Gauthier-Villars, 1906.) Price 2 francs.

DR. J. W. MELLOR, in his "Chemical Statics and Dynamics," p. 19, gives the following as the four stages of a physical theory:—hypothesis, differential equation, integration, observation. While this sequence is well illustrated in the study of dynamical phenomena, these, after all, constitute but a small proportion of the large number of effects in which changes are brought about by the action of definite causes. This book, while not containing any very novel and striking features, puts matters in a somewhat fresh light by giving prominence to the more philosophical aspect of the equations of mathematical physics and allied branches of science. Thus the motions determined by a constant force, a positive, and a negative force varying as the distance, are all characterised by different known forms of the integrals of the equations of motion. If in any phenomenon the changes which occur can be represented by equations of the form of one of these integrals, then conversely the relation between cause and effect may be of the same form as the corresponding law of force. The mathematical portion of the book is comparatively simple, and about the hardest problem considered is that of forced oscillations in a resisting medium. The book appears suitable for placing in the hands of such science students as have not the time to pursue an extended course in mathematics, as they would doubtless get many hints from its perusal. It may be doubted whether much is gained by the inclusion of physiological problems, such as the action of bacteria, in the present discussion, or whether such problems can indeed be adequately treated without introducing statistical considerations. But there are many cases where, even if the analogy be not exact, it is more easy to picture the progress of phenomena by associating them with dynamical or other analogues, and the book will be useful if it teaches students to think in this way.

The Steam-table. A Table of the Thermal and Physical Properties of Saturated Steam Vapor and of the Specific Heat of Water. Compiled from various sources by Prof. Sidney A. Reeve. Pp. ii+42. (New York: The Macmillan Company; (London: Macmillan and Co., Ltd.) Price 1s. 6d. net.

THIS is a very elaborate table from 400 lb. per sq. inch and 445° F. down to 0·18 lb. per sq. inch and 32° F. Usually we know a pressure in round numbers or a temperature in round numbers, and two separate tables are needed; Mr. Reeve's table contains both, and there is an ingenious arrangement for making interpolation easy. There are entries for every degree, and also for every pound per sq. inch. The usual error of such tables, using Regnault's heats with a value of Joule's equivalent which does not agree with Regnault's unit of heat, seems to be avoided by Mr. Reeve, and this steam-table seems to us likely to prove of very great value to steam engineers.

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.]*

Ionisation by Spraying.

IN a paper published in the *Philosophical Magazine* (February) I noted that positive and negative ions could be observed in large quantities by an Ebert apparatus if fine spray from water were produced profusely in its neighbourhood. Whilst much work has been done in connection with electrification caused by the bubbling of air through water and the splashing of drops, the effects due to spray do not appear to have received much attention.

A description of a simple method of studying the ionisation by spraying, with a preliminary note of some of the results obtained, may therefore be of some interest. A strong current of air, filtered through cotton wool, is passed for a definite time, usually half a minute, through a small glass sprayer, as supplied by Beckmann for introducing salts into a flame for spectroscopic work; but in the present case the air and spray pass together into the large lower chamber of an electroscope containing an insulated cylinder connected with a gold-leaf system in a small upper chamber. The leaf remains steady when air alone is driven into the lower chamber, except for a slight natural leak, which remains constant in spite of much spraying.

When spray has been introduced into the electroscope for half a minute the fall of potential is observed for that time, and from minute to minute until the leaf steadies to the natural leak. The effect terminates in two or three minutes in the case of water, but in the case of acetic acid, chloroform, ether, and the alcohols the ionisation effects do not disappear for ten to fifteen minutes, so that there are large inert ions, both positive and negative, present, some with a velocity of the order 10^{-5} cm./sec. in a field of 1 volt/cm. Similar results have been found by Aselmann for salt solution.

In most cases the positive and negative ions are generated in nearly equal quantities, but with water the negative ions are about 1·5 times as numerous as the positive. The same ratio holds for ether, of which the negative ions are more quickly removed than the positive. The most important point, however, is that small quantities of liquids can be examined by the help of these small sprayers, and definite results obtained for the substances, if care is taken to avoid impurities.

The following is a preliminary statement of the results obtained:—

Substances	Negative	Positive
Mercury	0 ...	0
Toluene	0·02 ...	0·02
Sea-salt and water	0·01	0·015
Hydrochloric acid and water ...	0·04 ...	0·04
Pentane	0·07 ...	0·03
Phenetol	0·08 ...	0·08
Benzine	0·14 ...	0·08
Ammonia water	0·45 ...	0·30
Tap water	0·65 ...	0·50
Distilled water	1·7 ...	1·0
Ether	3·7 ...	2·5
Chloroform, pure	2·3 ...	2·3
Chloroform, impure	4·5 ...	4·5
Acetic acid	3·2 ...	3·2
Methyl iodide	3·0 ...	3·0
Methyl alcohol	3·0 ...	3·0
Ethyl alcohol	3·5 ...	3·5
Amyl alcohol	4·5 ...	4·5

The figures are taken to an arbitrary standard and are expressed in terms of the positive ionisation due to distilled water. It may be better ultimately to select ethyl alcohol as a standard of comparison, because the ionisation due to water varies sharply when any impurity is introduced.

It is remarkable that volatile substances like benzine, pentane, phenetol, and toluene should give rise to little or no ionisation when sprayed, whilst ether, chloroform, alcohol, and aldehyde should so profusely form both positive and negative ions.

A. S. EVE.

McGill University, March 22.

On the Extinct Emeu of the Small Islands off the South Coast of Australia and probably Tasmania.

SOME of my colleagues in Australia, as I gather from "Notes" in NATURE (vol. lxxv., pp. 228, 467), have lately been at work on the identification of the small emeu of the islands in Bass Strait and Tasmania, now extinct. Prof. Baldwin Spencer, of Melbourne, having examined the bones of the emeu which once lived on King Island and found them smaller than those of *Dromaeus ater* of Kangaroo Island, has felt justified in proposing a name for that bird, and has called it *D. minor*. Colonel Legge, an old colonist, has also been working on the King Island emeu, and proposed for it a name, which, however, he withdrew in a postscript to his paper in favour of Prof. Spencer's one already published. From memory, having seen a pair in his boyhood, Colonel Legge considers the Tasmanian emeu a distinct *small* species.

Now I believe that the question of the emeus of small size which about a century ago yet lived in Tasmania and on the small islands off the south coast of Australia can only be settled by a careful comparison of their bones, and then, and then only, shall we know whether one or more species lived on those islands. I do not know of the existence in museums of specimens, either mounted skins or skeletons, of well authenticated Tasmanian emeus, but we possess two authentic skeletons and two mounted specimens of *Dromaeus ater* (Peron), which in the first years of last century was abundant on Kangaroo Island; two of these four specimens are in Paris, one is in Florence, and one in Liverpool. Mine is a skeleton, and is one of the three brought alive to France by Peron in 1803 from l'Ile Decrès (Kangaroo Island) (NATURE, vol. lxii., p. 102; *Ibis*, 1901, p. 1); the Liverpool specimen is, I think, not located; it is undoubtedly *D. ater*, but might hail from King Island or even from Tasmania; it may be the lost "lesser emea" of the Bullock Museum, dispersed in 1819.

I may now add that last summer my friend Mr. Alexander Morton, director of the Tasmanian Museum at Hobart, sent me some bones of the small emeu which he had collected on King Island, in Bass Strait, asking me to compare them with the corresponding bones of the skeleton of *D. ater* in this museum. I did so at once, aided by Prof. E. Regàlia, a high authority on ornithic osteology; the result of our careful comparison was that, barring some slight differences of purely individual value, the remains of the three specimens from King Island examined *were absolutely identical* with the corresponding bones of Peron's specimen from Kangaroo Island. I therefore wrote to Mr. Morton (from whom I have not heard since) that I had not the slightest doubt that *D. ater* (Peron) once lived on King Island, and unless new evidence should show the contrary, I am much inclined to favour the hypothesis that the same diminutive emeu once lived in Tasmania.

HENRY H. GIGLIOLI.

Royal Zoological Museum, Florence, March 29.

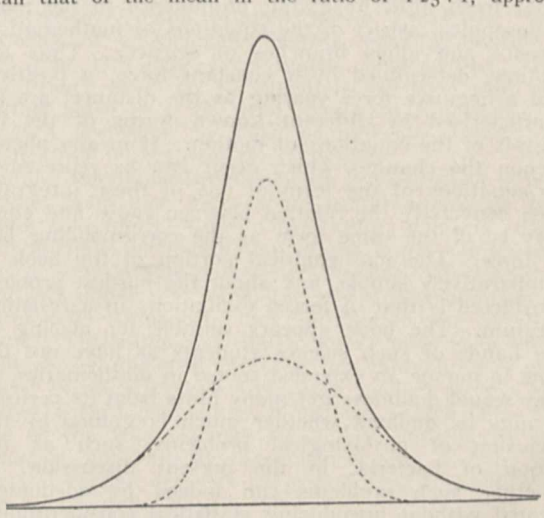
Mean or Median.

THE two applications of the *median*, suggested in Mr. Galton's letter (NATURE, February 28) and his article (March 7) respectively, seem to me to be somewhat distinct.

In the case of a jury or committee voting as to a sum of money to be given, there is no question of truth, but only of expediency. If any amount be proposed and put to the vote, the proposition will (by the ordinary way of voting) be defeated so long as that amount is above the median; the process of voting tends, therefore, to give an amount *not greater than* the median. Mr. Galton's suggested procedure is in this case, it seems to me, quite correct, and a saving of time would be effected if the problem were consciously approached from his standpoint.

The case of averaging a series of estimates with the view of arriving at objective truth appears to be on a different footing. If there is a considerable sprinkling of fools or knaves amongst the estimators, or of persons with a tendency to bias—as the buyers and sellers might be in judging the weight of cattle, according to the suggestion of Mr. Hooker—the question as to choice of means is one that is difficult to answer. The important question is, in fact, not the "probable error," but the probable *bias*, for the whole frequency distribution may centre round an entirely erroneous value. If, on the other hand, the observers are honest and unbiassed, the choice of average turns on the form of the frequency distribution; we require that average which is (1) least erroneous, as a rule, (2) least subject to fluctuations of sampling—two conditions which may very well conflict. As regards (1), psychologists, following Fechner, suggest the geometric mean, I believe, as the best. But the distribution of guesses given by Mr. Galton does not appear to follow the law of the geometric mean; if it did, the median should be less, not greater, than the arithmetic mean. Further, so far as one can judge, the geometric mean would give a value as much too low as the median is too high. Looking at the distributions in Prof. Pearson's memoir on errors of judgment (Phil. Trans., 1902), there seems very little to choose between the mean, the median, and the mode; sometimes one is the best and sometimes another.

As regards (2), the probable error of the median has been discussed on several occasions by Prof. Edgeworth (*Phil. Mag.*, 1886, 1887; Camb. Phil. Trans., xiv., 1885). The value is $0.674 \ldots /2h\sqrt{n}$, where h is the true ordinate of the frequency distribution at the median, *i.e.* $1/\sqrt{2\pi}.\sigma$ for the normal curve. For the normal distribution, therefore, the probable error of the median is greater than that of the mean in the ratio of 1·25 : 1, approximately. For a flatter topped curve with more curtate tails the ratio of probable errors is greater than 1·25 : 1, and accordingly for all such distributions the arithmetic mean is the better form of average. But for a curve with a high central peak and long tails, the probable error of the median may be less than that of the mean, and it will be the more stable form of average. As an illustration, Prof. Edgeworth has taken the case of a distribution compounded of two superposed normal curves with the same means and numbers of observations; if the standard deviation of the one is to that of the other in ratio greater than 2·236 : 1, the median has a lower probable error than the mean. The figure shows the critical distribution for which the probable errors of mean and median are the same.



In the absence of definite knowledge as to the frequency distribution of estimates in any specific case, it does not seem to me that any confident judgment as to choice of means can be given.

G. UDNY YULE.

March 26.

Golden Carp attacked by a Toad.

THE following account of a toad attacking a golden carp may be of interest to some of your readers from its bearing on an ancient belief that frogs and toads are at enmity with carp, and kill them by destroying their eyes. Izaak Walton in the "Compleat Angler" refers to this belief,

and states that frogs attack carp by "sticking fast" to their heads. Possibly naturalists, unknown to me, may have already thrown light on the origin of a tale which hitherto I have regarded as a fisherman's story of the conventional type.

On March 29 my son directed my attention to a large golden carp (*C. auratus*) lying in shallow water near the edge of a pond in my garden with a frog or toad apparently resting on its head. The fish appeared to be very sluggish, and made no attempt to escape from a landing-net with which it was easily brought to shore. On examination it was found that the head of the fish was held tightly by a medium-sized common toad (*Bufo vulgaris*), which had obtained a very firm grasp by inserting its fore-limbs as far as the second, or elbow, joint into the sockets of the eyes of the unfortunate fish. The ghoulish-looking toad lay on the top of the fish's head facing its tail, and with its hind legs hanging in front of the fish's mouth. At first the appearance of the eyes of the fish led me to think they had been ruptured, but closer examination showed they were merely displaced and turned partially round owing to the pressure exerted by the intrusion of the toad's limbs between the eyes and their sockets.

On carefully withdrawing the toad's fore-limbs, which were inserted to the extent of about 1 inch within the eye-sockets, the eyes returned to their normal position apparently uninjured, but during their displacement the fish must have been quite blind. No effort of the fish could have rid itself of the toad after it had once obtained the remarkably firm grasp which has been described, and it appears very probable that the fish would have died in a short time. How the toad in the first instance obtained a hold in the sockets of the fish's eyes appears very puzzling, but a probable reason for its attempt to obtain a grasp, and for it holding on when a grasp was obtained, may perhaps be found in the unreasoning instinct which toads appear to possess at spawning time of grasping something firmly with their fore-limbs. A few years ago in the same pond referred to above I found a toad embracing a water-logged puff-ball so firmly that it required considerable force to release the fungus from the amphibian's grasp.

ADRIAN J. BROWN.

Birmingham University, April 2.

The Atomic Weight of Nickel.

IN a recent number of NATURE (February 14, p. 367) Dr. Barkla gave reasons, based on experiments in connection with secondary Röntgen radiation, for assigning to nickel a new atomic weight. Dr. Barkla studies the penetrating power of secondary Röntgen radiation, shows that it depends on the atomic weight of the element, and from the values found for nickel, in comparison with those found for copper and iron, he argues that nickel appears to have the atomic weight of 61·3 instead of the usually accepted value of 58·7.

Prof. McClelland (Trans. Roy. Dub. Soc., vol. ix., part i., 1905) showed that the intensity of secondary β radiation from different elements for the same exciting primary β rays depended on the atomic weight, and that a small difference in atomic weight could be detected in this way. According to Dr. Barkla, nickel has an atomic weight somewhat greater than cobalt, instead of the value, slightly less, given by chemists. If this were so, the intensity of the secondary β radiation from nickel should exceed that from cobalt.

I have recently repeated the observations of Prof. McClelland, using a very sensitive apparatus. Cobalt and nickel gave practically the same secondary radiation; if there is any difference, that given by cobalt is slightly the greater. The values found for these elements, compared with those obtained for copper and iron, correspond with their relative positions in the table of atomic weights. These results obtained with secondary β radiation do not, therefore, point the conclusion suggested by Dr. Barkla, and are in good agreement with the chemical determination of the atomic weight of nickel.

F. E. HACKETT.

University College, Dublin.

Light Sense-Organs in Xerophilous Stems.

IN view of the recent work of Haberlandt on the light sense-organs of leaves, it may be of interest to record the discovery of similar organs in xerophilous stems. Certain of the epidermal cells of the young stems of the Ephedreæ have on their external wall conical structures of the nature of papillæ, the core of the papilla being mucilaginous. This structure acts as a collecting lens focussing the incident rays of light, and a definite area of the cytoplasm of the back wall of the cell is thereby illuminated. Fig. 1, which is a photomicrograph taken

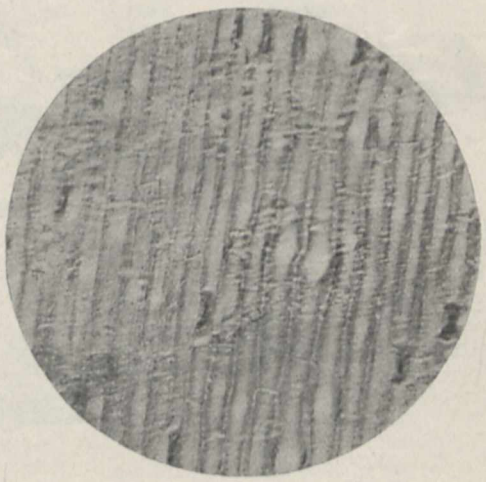


FIG. 1.—*Ephedra Altissima* showing Light Spots.

in diffuse light of a mounted preparation of epidermis, shows the appearance of these light spots as seen under 1/6 objective.

Of any object held in the path of the incident rays an image is formed by each of these light sense-organs.

Fig. 2 is a similar preparation to Fig. 1, but shows in each light spot the image of a hand held at a distance of about 2 feet in front of the microscope.

In the xerophilous Ephedreæ, where the assimilatory work is performed by the stems, and in correlation with

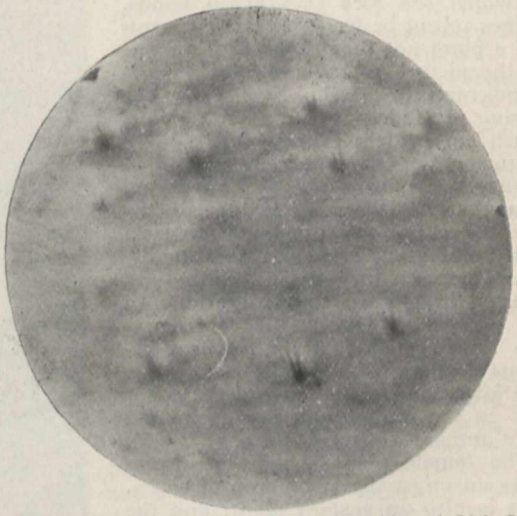


FIG. 2.—*Ephedra Altissima* showing image of hand in each Light Spot.

which the histological character of the cortex is markedly similar to that found in the mesophyll of a leaf, the existence of such structures as these light sense-organs so characteristic of leaves is not by any means unexpected.

An examination of other stems is in progress.

R. J. D. GRAHAM.

Botanical Department, University, St. Andrews, March 26.

THE LIVING WELWITSCHIA.

IN the course of a botanical expedition[1] in Damaraland from Walfish Bay to Windhuk I spent some days in January and February in the littoral desert (the Namib), where in several localities Welwitschia

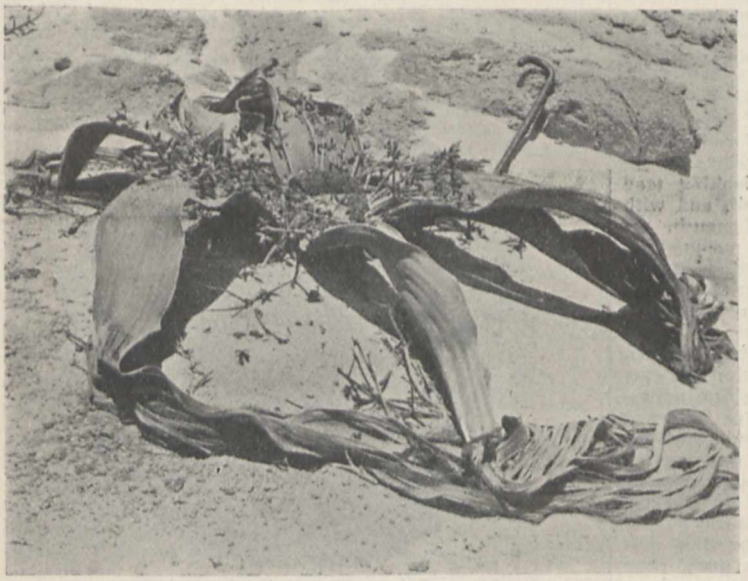


FIG. 1.—Welwitschia: Male Plant.

is abundant. Speaking generally, the cones seen this year on January 22 and on later dates were considerably more advanced than those examined on January 13, 1904. The plants are flowering quite as profusely as they were three years ago, and, excepting a number of immature specimens, few were without cones.

Fig. 1 shows a male plant the leaves of which are torn into broad bands. Baines might be forgiven for representing a plant not very different from this by the picture reproduced in Hooker's monograph (Plate i., Fig. 2). The tearing of the leaves into narrow strips, which on the whole seems to be more characteristic, is, I think, less common in the eastern part of the Damaraland area than in the west. The inflorescences (Fig. 2)—compound dichasia with decussating branches, occasionally reduced to solitary sessile cones—are inserted in pits on the outer ridge of the stem just within the leaf base. The ridge in the axil of the leaf remains fertile for a number of years. The lower flowers of most of the cones seen in the photograph are open, and their anthers are exserted.

The female plant shown in Fig. 3 bears an unusually large crop of cones. This is also an eastern plant, and the leaf-segments are few and broad. The bracts are deep, dull red in colour, except for a narrow margin of dark brown which extends for a short distance only on either side of the apex. The general effect is to mark out the four angles of the cone by longitudinal dark bands, which are separated by broader red bands along which the bracts overlap. In Fitch's picture (Hooker, Plate vii., Fig. 1) the angles of the cone are not sufficiently dark, and the colour of the remainder is too bright. The lower ovules appear to be pollinated. A drop of an intensely sweet viscous fluid was found on the summit of the projecting micropyle of each of the upper ovules during the day. It was not observed earlier than 9 a.m., but was common at 9.30 a.m. It remained there until after 3 p.m., but disappeared before sunset. Its formation was not due to a general increase in the turgidity of the plant, for it appeared before midday on inflorescences cut off in the early morning. Similar drops were seen under like conditions on all cones of corresponding size and colour.

I have elsewhere stated that the hemipteron *Odontopus sexpunctulatus*, which in Damaraland is always found on the inflorescences during the hotter part of the day, is not a pollinating agent, and have inferred, contrary to the opinion of Schinz, that the relation between the insect and the plant is one of parasitism only. This statement, founded as it was upon too hasty observation, is incorrect. Fourteen specimens captured in different places, some from male and others from female plants, and examined microscopically, were found in every case to bear pollen. The grains adhere singly or in masses to the smooth surface of the abdomen, or are caught up among the short hairs on the limbs. I have observed that as the insect walks over the cone the abdomen is touched by the exserted anthers in the one case and by the fluid-tipped micropyle in the other. There can therefore be no doubt that Odontopus is

FIG. 2.—Inflorescences of Welwitschia.

an important pollen-carrier, though, I believe, not the only one. The cones are also visited by a fly which is sometimes present in considerable numbers, and also by at least two species of Hymenoptera. In these cases the sweet fluid on the top of the micropyle is probably a source of attraction, but it

[1] In part assisted by a grant from the British Association.

is less likely that it exercises a similar influence on the visits of Odontopus. It may be suggested that pollination was once mainly effected by insects in search of nectar, and that the relations which now exist between the plant and Odontopus have been more recently established. This is the more probable, since this insect is so widely distributed in regions where Welwitschia does not occur. Possibly the coloration of the bracts at the time of pollination is also connected with the process. Certain it is that before the micropyles appear above the bracts the latter are green, and the red colour appears about the time of pollination. Further, there is no trace of a red colour in the many old specimens of seeding cones that I have examined, but I have not been able to make sure that the colour disappears while the cone is still attached to the plant, though I believe this to be the case. If this is so, the occurrence of yellow seeding cones in Hereroland specimens (as described by Pechuel-Lösche) is at once explained.[1] The native in this picture (Fig. 3) is a Herero. The shrubs in the middle distance are Sarcocaulon sp.

FIG. 3.—Welwitschia: Female Plant.

Through the kindness of Mr. K. Dinter, whose name is well known in connection with the botany of Damaraland, I was able to examine a bed of seedlings in the nursery of the forest department at Okahandya. The seeds were sown in July last in a deep, well-drained, sandy soil, and germinated in about two weeks. A specimen which I was allowed to take up on February 7 had an exceedingly slender tap-root with a few short branches; the main root (the tip was left in the ground) measured 20·5 cm. below the feeder, the oldest branch being 11 cm. below the same level. The fairly stout hypocotyl was 2 cm. long, the foliage leaves 4·5 cm.; the cotyledons were dry and shrivelled, and the lateral cones represented by small, vertically placed green lamellæ. The comparatively rapid elongation of the root, altogether out of proportion, on the one hand, to its own growth in thickness, and on the other to the increase in size of the aërial parts, points to the existence of a supreme necessity that the absorbing root should reach an underground source of water and as soon as possible render the plant independent of the very scanty and infrequent supply at the surface. In nature the conditions which would induce germination, and at the same time enable the root to penetrate the surface layers to a sufficient depth, must very rarely occur, and it is not surprising that young seedlings have been searched for in vain. This apparent failure of natural reproduction by seed in recent years, when considered in relation to the large number of plants found within a comparatively small area and their obviously slow growth, suggests that the life-conditions now prevailing in this Welwitschia area are more severe than formerly. There is other evidence also pointing to the same conclusion. Vegetative reproduction being entirely wanting, it is difficult to escape the conviction that, with the continuance of existing climatic conditions, the species, here, at least, is approaching extinction.

I am very deeply indebted to His Excellency Herr von Lindequist, Imperial Governor of German South-West Africa, and to Herr Regierungsrath Dr. Hintraeger, Acting Governor, through whose kindness every assistance which the Government could possibly give me in the study of Welwitschia, and in a subsequent journey further inland, was most generously afforded.

H. H. W. PEARSON.

[1] *Cf.* Fichler, in Engler and Prantl, "Pflanzenfamilien," ii., 1, p. 124 (footnote).

THE ART OF EMBALMING IN ANCIENT EGYPT.[1]

PROF. ELLIOT SMITH has applied to the study of mummification the accurate and thorough methods of observation which have won for him a foremost place among the younger generation of anatomists, the result being an authoritative memoir, which will serve both the expert and the uninitiated as an excellent introduction to the art and significance of embalming as practised in ancient Egypt. As professor of anatomy in the medical school at Cairo he has free access to the material necessary for a first-hand study of the subject. So well has he pieced his evidence together that one obtains on reading it a very complete picture of the actual process employed by the embalmers during the twenty-first dynasty. The memoir is based on a study of forty-four mummies of priests and priestesses of Ammon, belonging to that dynasty.

Although the chief object of the author was to unravel the details of the embalmer's art, he carefully collected all evidence which might throw light on the significance of a custom which was practised for a period of at least two thousand years in Egypt—from the seventeenth dynasty until about 600 A.D. During the twenty-first dynasty, embalming culminated in an elaborate technique which aimed at preserving the integrity of the skin and restoring the living form to the body. In explanation of the elaboration of technique during this period, Elliot Smith brings forward a suggestion of Dr. Reisner (in charge of the Hearst Egyptological Expedition of the University of California), namely, that the procedure had as its object a life-like preservation of the body so that it might serve as an abode for the *Ka* or "double," in place of the statue which was usually placed in the tomb along with the dead body to

[1] "A Contribution to the Study of Mummification in Egypt." By Prof. G. Elliot Smith. Pp. 53+plates. Mémoires présentés à l'Institut Égyptien et publiés sous les auspices de S. A. Abbas II., Khédive d'Égypte, Tome v., Fasc. i. (Cairo, 1906.)

answer this purpose. Whatever the object may have been, there can be no doubt as to the tedious and complicated nature of the means employed.

Before the twenty-first dynasty, the process of embalming resulted in a mummy which was simply a skeleton wrapped in a wrinkled covering of shrivelled skin. In this dynasty, or at the close of the twentieth, the process of packing or "stuffing" was introduced to avoid the shrivelling of the flesh and distortion of the body which marred the work of the older embalmers. The mortal flesh was replaced by subcutaneous packings of durable material such as mud, sand, lime, and sawdust, with occasionally an addition of aromatic vegetable substances such as onion. The eyes of the great Rameses IV. were replaced by onions. After the twenty-first dynasty, the art of embalming declined. Subcutaneous packing was discontinued, the surface form of the body being restored by swathing the limbs and body by an artistic application of bandages; later still all distortion was hidden by a free application of pitch and bandage to the shrunken trunk and limbs.

In the course of his investigations, Elliot Smith was able to verify certain statements made by Herodotus and by Diodorus Siculus concerning the methods of embalming employed by the ancient Egyptians. Herodotus describes the extraction of the brain through a small opening made on the roof of the nasal cavity—a procedure which Greenhill characterised as "amusing and impracticable." It was found that all the mummies belonging to the seventeenth and later dynasties showed clear evidence of the truth of the ancient description; early in last century, T. J. Pettigrew also verified it. In the writings of Pettigrew and in Brugsch's translation of the Rhind Papyri, the author of the memoir found much that assisted him in re-constructing the details of the process used by the embalmers. Broadly speaking, there were three stages: (1) the viscera were removed from the body through a wound in the left flank, the heart being invariably left in the trunk; (2) the body was then placed in brine for a period of thirty or forty days; the viscera were preserved in a similar medium within the four "Canopic Jars," each of which was dedicated to one of the four children of Horus; (3) after removal from the salt bath the body, now much shrunken, was packed; from the arrangement of the packing, Elliot Smith found it possible to tell the exact manner and order in which this had been accomplished; it is unnecessary here to mention the details, but one may safely state that these ancient embalmers must have had a very considerable knowledge of the anatomy of the human body.

The process of packing was finished by returning the contents of the four canopic jars to the body cavity; they were arranged in four packages, and were usually replaced within the cavity in a certain definite order. In each package it was the custom to enclose the image of one of the four children of Horus —"funerary genii," as they are named in this memoir.

The following statement of Pettigrew is quoted in this connection :—

"To Amset were dedicated the stomach and large intestines; to Hapi the small intestines; to Smautf (Tuamâutef) the lungs and heart; and to Kebhsnuf the liver and gall bladder."

On this Prof. Elliot Smith makes the following commentary :—

"The examination of a still larger series of mummies of this period (twenty-first dynasty) has convinced me that, in spite of frequent irregularities, a definite association was intended—but the guardianship of the various Genii is by no means identical with that suggested by Pettigrew. Thus the human *Amset* is usually found wrapped up in the *liver* instead of the stomach and large intestines, the ape-headed *Hapi* is usually associated with the *left lung* rather than the small intestines, the Jackal *Tuamâutef* with the stomach . . . and the hawk-headed *Kebhsnuf* . . . in the parcel of intestines."

There are many other points in this memoir which are deserving of notice, but enough has been said to show its value as a real contribution to our knowledge of the ancient Egyptians.

ASTRONOMICAL REFRACTION.

WHEN a ray of light passes through a medium of uniform density, the path described is a straight line. Should this ray meet obliquely another medium of different density it is bent or refracted. If the second medium is more dense than the first, then the ray as it enters the second medium is refracted towards the normal, or that line at right angles to the tangential plane at the point where the ray enters the second medium.

In the case of astronomical refraction, the light, say, from a star, passes through space and then penetrates the earth's atmosphere, a medium which is in all parts denser than the space between the star and the upper limit of the earth's atmosphere. By the time the ray reaches the observer it will therefore be considerably bent towards the normal. If our atmosphere were homogeneous, that is, if it were of equal density throughout, the star's light would pass in a straight line from the point where it first penetrated it to the observer's eye. We know, however, that our atmosphere is far from being of uniform density, and one has not to climb a mountain or ascend in a balloon very high before this fact is made plain.

Up to a few years ago little was known with certainty about the physical conditions of the upper atmosphere, except the broad idea that the air became less dense the greater the distance from the earth's surface, and that at the same time the temperature readings were lower and lower.

This limited knowledge of our atmospheric conditions rendered it necessary to make some assumptions as to the law of decrease of density. This was imperative, because it was of vital importance to astronomers and mariners to know how much the ray of light from a celestial object had been bent after it had penetrated our aërial envelope. In fact, what was required was the difference between the apparent and actual direction of the heavenly body in the sky.

The assumption finally made was that the atmosphere consisted of a series of concentric spherical layers the common centre of which was the centre of the earth. Each layer was considered of uniform density, and these densities or temperatures and refractive powers all decreased as the surface of the earth was left behind, the amount of decrease varying in a prescribed way and agreeing in the main with the actual, but few, observations made in balloons and on mountain tops. On this assumption, then, the ray which entered our atmosphere was always meeting with denser and warmer layers of air, and gradually becoming more and more bent as each consecutive layer was passed through.

During the course of the last few years very rapid strides have been made in investigating the upper air by means of manned and unmanned balloons and kites carrying meteorological instruments, and eleva-

tions have been reached which formerly were impossible to attain. The data collected at various heights above the earth's surface have now, therefore, become considerable, and our knowledge of the distribution of atmospheric temperature has in this way been greatly advanced. Thus it is known that the temperature does not gradually decrease as greater elevations are reached at the rate that was previously assumed. In fact, numerous records from automatic instruments have shown that at some heights quite considerable rises in temperature, extending through large depths of atmosphere, have been noted, these inversions being far more common than was at first contemplated.

With this condition of things so prominently brought out, it is at once obvious that some attention should be paid to a possible revision of the assumption on which the theory of astronomical refraction is based, because the path of a ray of light traversing such variously heated layers may not be the same as that computed on the old hypothesis.

Fortunately this question is now receiving some attention, and this is shown by a recent preliminary paper by Prof. H. G. van de Sande Bakhuyzen entitled "On the Astronomical Refractions Corresponding to a Distribution of the Temperature derived from Balloon Ascents," which appeared in the *Koninklijke Akademie van Wetenschappen te Amsterdam* (January 26).

In this investigation Prof. Bakhuyzen has employed observations made on 182 different days, of which fifty-eight were made with unclouded and 124 with clouded sky. The ascents were made from Halde (in Denmark), Berlin, Paris, Strassburg, and Vienna, so that the values which he gives for temperatures at heights from 0 kilometre to 16 kilometres apply to the mean of the area enclosed by those stations. The values for the means above 13 kilometres are, as he states, not very certain, but the observations indicate that the temperature at these heights decreases slowly.

As this table is of considerable interest, a portion of it may be given here:—

Temperatures (centigrade) at heights from 0–16 kilometres for clear weather.

Height	Annual mean	Diff.
0	+ 6°·4	
		− 1·1
1	+ 5·3	
		− 4·3
2	+ 1·0	
		− 4·8
3	− 3·8	
		− 5·5
4	− 9·3	
		− 6·1
5	−15·4	
		− 6·4
6	−21·8	
		− 6·7
7	−28·5	
		− 7·3
8	−35·8	
		− 7·4
9	−43·2	
		− 6·4
10	−49·6	
		− 5·1
11	−54·7	
		− 2·3
12	−57·0	
		− 1·0
13	−58·0	
		− 0·6
14	−58·6	
		− 0·4
15	−59·0	
		− 0·2
16	−59·2	

The result of this preliminary investigation shows that when the refractions for zenith distances greater than 85° have been determined, the values for these alone are given in the paper, the values deviate perceptibly from those deduced from Ivory's theory.

Even if great weight be not put on this result, the inquiry is one which should undoubtedly be taken up again when more data are forthcoming. The astronomer of to-day is perhaps inclined to look upon the results of the computation of refraction by methods at present in use as strictly correct, but evidently due regard must now be paid to new data rendered available by atmospheric soundings. The subject of Prof. Bakhuyzen's inquiry is therefore of considerable importance, and future research in this direction will be followed with interest.

NOTES.

IN the issue of the *Revue Scientifique* for March 30 are re-printed portions of the funeral oration delivered by M. Briand, the Minister of Public Instruction, at the national funeral of M. and Mme. Berthelot at the Panthéon on March 25. M. Briand, speaking of Berthelot, said:—"The illustrious man of science, the great Frenchman for whom we mourn, was one of those colossal men who are an honour to every country and every age. He thought it the duty of every citizen to interest himself in the affairs of his city, and that is why his life was so multiplex, why his activities were exercised in such various directions. Probably he would have preferred to give all his time to his laboratory and his favourite studies; but when the public interest called him, when it looked to him to place his science at the service of the national defences of education, of general politics, Marcellin Berthelot did his duty simply, and we have thus to celebrate to-day at the same time the man of science, the philosopher, the educator, the politician and *l'honnête homme*." Toward the close of his oration M. Briand remarked that he had been called by his position "to the painful and formidable honour of rendering homage, in the name of the Government, to the man of genius for whom universal science is in mourning"; he then proceeded to give a touching eulogy of Berthelot as a private individual. The discourse serves admirably to show the high esteem in which the French people and rulers hold their great men of science.

DR. NANSEN will give a paper on "Polar Problems" at the Royal Geographical Society on Monday, April 29; on May 13 a paper on "An Expedition from the Niger to the Nile" will be read by Lieut. Boyd Alexander.

AT the recent annual meeting of the Royal Irish Academy Prof. F. A. Tarleton was elected president for the session 1907–8, and the following were elected honorary members in the section of science:—Profs. Ramon Y. Cajal, Madrid; W. Ostwald, Leipzig; E. C. Pickering, Cambridge (Mass.), U.S.A.; and H. Poincaré, Paris.

A REUTER message from Constantinople reports that considerable damage has been done to property at Bitlis by violent earthquake shocks on March 29.

ON Tuesday, April 9, Prof. G. H. Bryan, F.R.S., will begin a course of two lectures at the Royal Institution on "Wings and Aëroplanes"; on Thursday, April 11, Prof. H. A. Miers, F.R.S., will commence a course of two lectures on "The Birth and Affinities of Crystals," and on Saturday, April 13, Prof. Silvanus P. Thompson, F.R.S., will begin a course of three lectures on "Studies in Magnetism" (the Tyndall lectures). The Friday evening discourse on April 12 will be delivered by Prof. A. H. Church, F.R.S., the subject being "Conservation of Historic Buildings and Frescoes," and on April 19 by Prof. C. S. Sherrington, F.R.S., on "Nerve as a Master of Muscle."

MR. ANDREW CARNEGIE has invited a large party of guests from England to attend the dedication of the new building of the Carnegie Institute at Pittsburg, Pennsyl-

vania. A large contingent of the party left Liverpool on Wednesday last for New York by the White Star steamer *Baltic*, among them being Sir Robert Ball, Provost and Mrs. MacBeth, Prof. Rhys, Principal of Jesus College, Oxford, Mr. and Mrs. John Robertson, and Dr. John Ross.

THE death is announced of Prof. J. K. Rees, formerly professor of astronomy in Columbia University, New York. Prof. Rees was for two years president of the New York Academy of Sciences, and for fourteen years secretary of the American Meteorological Society. His principal observational research was a study of the variation of terrestrial latitudes and the aberration of light, made in cooperation with the Royal Observatory, Naples. This work was continued from 1893 to 1900, and was the first application of the method of simultaneous observations at two stations situated on the same parallel of latitude, but separated widely in longitude. It was during Rees's professorship that Columbia University undertook the publication of Rutherford's series of star photographs. He also established the Columbia summer school of geodesy, and early recognised that practical field work in this subject is an indispensable adjunct in the training of civil engineers.

AMONG the scientific subjects for which prizes are offered by the Reale Istituto Lombardo, we note the following:—for the Cagnola prize, April, 1907, on the discovery of radio-activity and its influence on modern physical and chemical theories; for 1908, on the present state of metallography in relation to the physical properties of metals, particularly iron and steel, a general summary including some original results for the Fossati prize for 1907, on the so-called nuclei of origin and termination of the cranial nerves; for the Kramer prize for 1907, a discussion with certain practical applications of Guglielmini's hydraulic theories; for the Secco Comneno prize for 1907, a discovery relating to the virus of rabies; for 1911, on the physiological action of high-frequency currents. As in previous years, other prizes are offered for literary and commercial subjects and for subjects which are the same every year. For the present year the prize awards of the Reale Istituto Lombardo include a Cagnola prize of 100*l.* and medal of value 20*l.* to Dr. Augusto Moschini, of Pavia, for his essay on the pathology of the suprarenal capsules; a prize of 80*l.* to Dr. Guido Sala, of Pavia, and awards of 20*l.* to Prof. Domenico Lo Monaco and G. Pitò, of Rome, for essays on the anatomy of the visual centres of higher vertebrates under the Fossati foundation; and Kramer prizes of 80*l.* each to Ernesto Canalli, of Naples, and Mario Baroni, of Milan, for essays on the resistance of structures in cement.

A REUTER message states that Mr. Walter Wellman will again attempt to reach the North Pole by airship during the coming summer. The expedition steamer *Frithjof*, which is now at Trondhjem, is to be ready to leave Tromso, with the expedition on board, for Spitsbergen, on June 1. The party will consist of about thirty-five men, and will proceed at once to the expedition base at Dane's Island, established last year, where three men are now living. The balloon part of the airship *America* has been rebuilt in the ateliers of M. Mallet, Paris. The airship is 183 feet in length, with a greatest diameter of 52 feet. Its volume is 265,000 cubic feet, and when inflated the lifting force will be 19,500 lb. The car itself is 115 feet in length, of steel tubing, remarkably light and strong. The backbone of this car is a steel reservoir of equal length to contain 1200 gallons (6800 lb.) of petrol for the motors. The principal motor, a 60 to 70 horse-power Clement, works directly on two steel screws, 11·5 feet in diameter, placed at each side of the car. The proper speed of this airship is sixteen to eighteen statute miles per hour, and the fuel carried gives 150 hours of motoring at full speed; radius of action, more than 2250 miles, or nearly double the distance from Spitsbergen to the Pole and back again. All the mechanical part is being thoroughly tested by weeks of running, and at Spitsbergen trials will be made in the air of the completed ship before attempting the voyage to the Pole. It is intended to reach the expedition base at Spitsbergen the first week in June, to have trials of the airship in July, and to start for the Pole in the latter part of that month, or in the first half of August.

A CORRESPONDENT sends us from Leal, Russia, some interesting particulars concerning the life and work of Dr. Jakob Hurt, the "keeper of Esthonian folk-lore," who died on December 31, 1906 (old style), to the great grief of all Esthonians. Dr. Hurt was born on July 10 (old style), 1839, at Wõru-maal (Werro district), Põlwa parish. In 1859–63 he studied theology in the University of Tartu (now Jurjew), and after some years as lecturer in the gymnasium of that town was elected pastor to the parish church of Otepää, where he remained from 1872–80. As the Esthonian population in St. Petersburg grew, Dr. Hurt was called to minister in their native tongue in the Church of St. John, where the Esthonian congregation numbers now about 30,000 souls. He remained there from 1880–1901. His literary work was so great that he sacrificed his pastorage and devoted all his time to the native literature. In his early years he became keenly interested in this subject, and listened to old folks' chants and legends, which he recorded and published under the title of "Vana Kannel"—the Old Harp. These songs awakened a strong feeling among the people, and a collection began in 1888 which is now represented by 160 volumes of MSS. Only two volumes have appeared, and a third is in print as "Setukeste Laulud," or the songs of Setukesed. The whole national collection of Esthonian folk-lore now includes 60,000 records of superstition, 52,000 proverbs, 45,000 folk-songs, 40,000 enigmas, and 10,000 folk-tales. The death of a folklorist who could accumulate such a vast amount of material is a loss, not to the Esthonians alone, but also to the world at large. The Esthonians were almost a dead nation when Dr. F. R. Kreutzwald (1803–1882) published his "Kalewipoeg"—the Esthonian Homer's "Iliad"—which brought them to notice. The number of Esthonians is about one million. The limit of the Esthonian language extends from Reval (Tallinn) so far south as Walk in Livonia. There are many settlements of Esthonians in European Russia, Caucasia, Siberia, and in the United States, Canada, and other parts of the world. It will be a great loss to the world if the valuable material collected by Dr. Hurt is not preserved for future publication, and every effort should be made to secure this result. The English Folk-lore Society would probably help in this matter, and other societies might also do something. The sacrifice of the collection would be a misfortune to science as well as to the Esthonian nation.

SOME observations which help to explain the frequent occurrence of anhydrite in beds of gypsum have been made by Mr. Louis C. Kemp, and are described in a note received from his father, Mr. W. I. Kemp. Mr. Kemp finds that anhydrite is readily formed from gypsum in solution in a steam boiler working at 60 lb. pressure per square inch. Having occasion to examine some of the boiler sludge, precipitated from the mine water which had been used in

the boiler, he found the sludge to be almost pure anhydrite in fine crystals, and was confirmed in his observation by Dr. Gerald T. Moody, to whom part of the sample was sent.

ARE there any instances of church bells having been cracked by sound waves produced in air by explosions or heavy firing? A note in the *West Sussex Gazette* of March 28 suggests that this happened recently in the village of Appledram, Sussex. Three volleys were fired by a naval party of twenty-four men over the grave of a seaman buried in the churchyard. On the evening of the same day one of the church bells, nearly six hundred years old, was found to be cracked. The firing party was only about a dozen yards from the belfry, and it is believed that the vibration caused by the three intense sound waves in rapid succession cracked the bell. It is well known that explosions and heavy firing have often broken windows, but we do not remember any case of a bell being damaged in this way. No windows were broken in the Appledram church, so apparently the effect was not due simply to compression waves. It would be interesting to know whether there are other cases of bells having been cracked in the way that glass globes are said to have been broken when set in violent vibration by sound waves.

ON January 8 Prof. Willis L. Moore, chief of the U.S. Weather Bureau, was asked by a committee on agriculture of the House of Representatives at Washington certain questions in regard to rainfall and change of climate in the United States. The actual questions and answers have been reprinted in pamphlet form, and the information given by Prof. Moore is to the effect that the climate has in no way changed during recent years. With regard to the rainfall in Kansas, Nebraska, and other States, a table giving the means for thirty years, in periods of ten years, clearly shows that the aggregate amounts have neither increased nor diminished to any extent worthy of consideration. The first and last ten years were periods of fairly abundant rainfall, while in the middle ten years there was a deficiency. During the last few years there has certainly been an excess of rainfall in some districts, but Prof. Moore pointed out that as long a period of drought may be looked for later on. This very natural and valuable opinion appears to have given offence to some newspapers in Kansas as being injurious to the States in question, and likely to prevent the sale of land. Time will show that the attack they have made upon Prof. Moore is both unwise and unwarranted. His evidence is at least the outcome of knowledge obtained from a study of the best materials available to the Weather Bureau.

INTEREST in natural history is encouraged by a series of articles on the country month by month which is appearing in *Pearson's Magazine*. In addition to an illustrated article on the nature-story of April, with notes on the birds and flowers of the month and a calendar of the chief natural history events, the current number contains a contribution on the fertilisation of clover. This article gives an instructive account, with several striking photographs, of cross-fertilisation of white Dutch clover by bees, but the remark that clover plants are "wise in their day and generation" because their structure favours this process is, to say the least, misleading. Human attributes are implied even more definitely in the remark, "One cannot fail to admire the clover for its broad-mindedness in not only thinking of its own immediate well-being, but working and arranging for the future, that its progeny should be vigorous and healthy." It is a pity to use expressions of this kind when referring to the functions of flowers. A story entitled "A Message from the Moon" describes how an advertisement was projected by a parabolic reflector from the earth to the unilluminated part of the moon's surface. The idea is ingenious enough, but unfortunately the author and his illustrator make the usual mistakes about the crescent moon. The pictures show the advertisement on the dark part of an old crescent moon setting in a night scene, whereas such a crescent can, of course, only be seen shortly before sunrise. The author takes the same liberties with the moon's motions by describing the moon as rising at New York at night in crescent form with the advertisement visible upon it for "upwards of three hours and a half, that is, until the moon was well overhead." We advise the author and the artist to make a few observations of the rising and setting crescent moons, and they will soon learn that the positions in which they place our satellite can never be realised in nature.

WE have to acknowledge the receipt of a copy of a "Catalogue of British Orthoptera, Neuroptera, and Trichoptera" (fifteen pages), by the late C. W. Dale, published by Messrs. Harwood, of Colchester.

Museum News (Brooklyn, N.Y.) for March records the bequest, by Mrs. C. H. Polhemus, to the museum of a number of pictures, bronzes, &c., of the estimated value of 8000*l.*, together with a sum of money for the preservation and increase of the collection.

FROM the British Museum (Natural History) we have received a copy of a "List of British Seed-plants and Ferns," price 4*d*. The list, which has been drawn up by Dr. Rendle and Mr. Britten, excludes some introduced and all exterminated plants, as well as many of the phases of Rubus, Salix, &c., together with the Channel Islands flora. Plants which, although introduced, appear to have become naturalised, are indicated by italic type.

A COPY of the second edition of the illustrated penny guide to the Hull Municipal Museum, compiled by Mr. T. Sheppard, the curator, has been received. The collections date from the year 1823, and include, among other valuable specimens, the type-skeleton of Sibbald's rorqual (*Balaenoptera sibbaldi*), prepared from a carcase stranded at Spurn in 1836, and named by Gray in 1847. A photograph of this skeleton forms one of the illustrations.

THE histology and development of the divided eyes of certain insects form the subject of a paper by Mr. G. D. Shafer in the Proceedings of the Washington Academy of Sciences (vol. viii., pp. 459–486). The first part is devoted to the histology of the compound eyes of such forms as Sympetrum, the dragon-flies of the genus Anax, and the midges of the genus Callibætis, which are divided by a curved line into an upper light-coloured and a lower dark moiety; while in the second the author discusses the development of the large-facetted area of the eye of the first and third of these groups. In the case of the "turban-eye" of Callibætis, the formation of a superposition image on the proximal and an apposition image on the distal retinulæ enables the eye with the superposition image to see, although perhaps indistinctly, in dim light where the small-facetted, deeply pigmented eye would be useless. As these turban-eyes are restricted to the males of these may-flies, which seek the females during flight in the gloaming, their use is obvious.

"MERISTIC Homologies in Vertebrates" is the title of a thoughtful article by Mr. J. S. Kingsley in the February number of the *American Naturalist*. As one of the difficul-

ties of the subject, the author points out that whereas mammals have twelve cranial nerves, in frogs and other ichthyopsidans the number is but ten. Consequently, the question arises whether the two additional nerves in the mammal are not due to the inclusion of two segments of the amphibian neck in the cranium of the former. If this be admitted, there is a strong *primâ facie* probability that the occipital condyles of the frog are not the homological representatives of those of the mammal. On the other hand, certain phenomena in annelids lead to the conclusion that segments, or somites, may be intercalated in various parts of the body by means of budding. If such a process exist in vertebrates, we could readily account for the two additional pairs of cranial nerves (representing as many segments) in the mammal as compared with the frog, without interfering with the homology of their condyles. So far, however, as the author is aware, no such budding zone is known in any vertebrate, and the hypothesis must consequently be regarded as merely of a tentative nature.

To the February number of the *Zoologist* Mr. T. Southwell contributes notes on Arctic whaling in 1906. The take of right-whales was very small, the total number being only seven (four from East Greenland, two from Davis Strait, and one from Hudson Strait), and it was only the high price of bone—about 2500*l.* per ton—that rendered the venture profitable. The most noteworthy feature is the capture of the four whales in East Greenland waters, where none had previously been taken since 1889. The capture suggests that there are more whales in these waters than is generally believed, their accessibility or otherwise being largely dependent upon the condition of the ice. The author directs special attention to the capture of four Atlantic right-whales by the Harris whalers, and likewise to the arrival of a cargo of "bone" from the same species (regarded a few years ago as nearly extinct) at New Bedford. In the March number of the same journal Mr. A. H. Paterson, of Yarmouth, gives some interesting particulars of the flocks of wildfowl and other birds which visited Norfolk at the time of the great snowfall of last Christmas. No less than about sixty swans were observed at Breydon, the majority of which appeared to be whoopers, although at least one is believed to have been of the Polish species, and pochards were vastly more numerous than for many years past.

PART iii. of the fifth volume of *Biometrika* was issued in February. The opening article is Mr. Raymond Pearl's "Biometrical Study of Conjugation in Paramecium," concerning which some correspondence took place in our columns last autumn (vol. lxxiv., pp. 465, 584, 608). The memoir is of great interest. It is found that conjugants are differentiated from non-conjugants not only in type, as was well known, but also in variability and in correlation. Conjugant types from various sources differ less *inter se* than non-conjugants. The dimensions of the two members of a conjugant pair are highly correlated, and it is shown that this is almost certainly due to the fact that the two must fit—to put the matter shortly—or else they do not adhere, and sooner or later separate. The significance of these important results is discussed with care in considerable detail. Mr. J. F. Tocher contributes an account of an anthropometrical survey of the insane in Scotland, carried out at the cost of the Henderson trust under his direction; stature and head dimensions were measured, and pigmentation noted, for more than 8000 cases in the Scotch asylums. The memoir is illustrated by maps, and the whole of the original data are reprinted, by permission of the Henderson trust, as a supplement. A short article by "Student" deals with a point of practical interest, viz. the fluctuations of sampling to be expected in counting with a hæmacytometer, and in similar operations. For example, in order to obtain pure cultures of a yeast, the fluid is diluted until it is estimated that every two drops contain on the average one cell; different flasks are then seeded with one drop each, and it is assumed that "the majority of those flasks which show growth are pure cultures." But the question arises, what actual proportion may be expected to be pure? The answer is, about 76 per cent.; 19 per cent. will have been seeded with two cells, and the remainder with three or more. As no references are given in the article, we may point out that the series used as a limit to the binomial when one of the chances is very small, is not novel; it was deduced by Poisson ("Recherches sur la Probabilité des Jugements," § 81, p. 206), and has been discussed in detail, with illustrations, by Bortkewitsch ("Das Gesetz der kleinen Zahlen," Leipzig, 1898).

AN account of the mosses collected at Westende and Coxyde, in Belgium, on the dunes, sands, and reclaimed lands known as "polders," combined with a discussion of the physiological factors regulating their distribution, is contributed by Dr. J. Massart to the *Bulletin du Jardin botanique*, Brussels, vol. i., No. 6. About sixty species were collected, of which *Syntrichia* (*Tortula*) *ruraliformis* was the most characteristic and widely spread.

IN the report of the Government laboratories at Manila for the year 1905–6, the superintendent, Mr. P. C. Freer, reviews the general lines of research carried out in the biological, chemical, and serum laboratories; he also formulates a plan for the establishment of a marine biological laboratory, and raises the question of founding a medical school in the Philippine Islands. Incidentally, Mr. Freer insists upon the necessity, that is not always rightly appreciated, for systematic botanical and entomological work, seeing that correct identification of plants or animals is an essential preliminary to the prosecution of investigation on economic products.

IN *Petermann's Mittheilungen*, vol. iii., part ii., Prof. F. Höck presents the first part of a study of the phytogeographical boundaries and regions of northern Germany. Beginning with the vegetation of East Prussia, the author states that the eastern boundary of the beech and the western limit of certain plants of the moors and swamps lie in this province, so that it may be regarded as a transition district between Russia and north-western Germany. The botanical region of north-western Germany is contrasted with the adjoining botanical provinces of lower Saxony, Schleswig-Holstein, and the Netherlands, all the latter containing various North Atlantic species that are absent in north-western Germany.

UNDER the title of the "Century Plant," Prof. W. Trelease contributes an article on the more important species of Agave to the March number of the *Popular Science Monthly*, New York. The chief value of many of the Agaves grown in Mexico lies in the fermented liquors prepared from the sap. In the plains of Apam, south of the City of Mexico, the sap is collected from extensive plantations of *Agave atrovirens* to make "pulque." "Mezcal" is a liquor obtained by distillation in another part of Mexico from *Agave Tequilana* and other species; "sotol" is the product of plants of the liliaceous genus Dasylirion. Reference is also made to the varieties that furnish sisal-hemp and other fibres.

BOTANICAL survey work concerned with the mapping of the vegetation of a given area according to a plan which is the outcome of a method suggested by Prof. C. Flahault, of Montpellier, has attracted a small but energetic band of workers in the United Kingdom. The latest survey prepared by Mr. C. E. Moss, dealing with the distribution of vegetation in Somerset, was published in the *Geographical Journal* (October, 1906). In the lowland areas Mr. Moss traces the transition from dunes fixed by sea-couch grass, *Agropyron junceum*, and marram-grass, *Ammophila arundinacea*, to dune ponds and dune pastures, and so to maritime farmlands. In another sequence of associations, the salt marsh, at first settled with Salicornia, is converted into land suitable for growing osiers and tree willows. Similarly, typical series of formations are described for the upland areas, which are as markedly characteristic and easily recognised, so that the present paper provides an admirable introduction to anyone taking up the subject.

MESSRS. CARL ZEISS, of Jena, have forwarded a copy of their price-list relating to large projection apparatus. This list contains a brief reference to everything necessary for the projection of microscopic objects, transparencies placed horizontally or vertically, and opaque objects. Some general information is also given as to selection of the optical equipment for special purposes.

IN the Journal of the Royal Microscopical Society, Mr. J. W. Gordon describes a top stop for the microscope. This is placed in the Ramsden circle of the instrument, its effect being to cut off the central part of every beam of light. In this way the advantages of a wide aperture are preserved, and the definition is improved, as is well shown by the photographs illustrating the paper. This improvement is attributed to the fact that in an unstopped beam the central and marginal parts do not exactly form the same image, and the confusion thus caused is obviated by the stop. To cut off the marginal rays would be merely equivalent to using a narrower aperture.

RECENT progress in the industry of perfumery and essential oils is ably summarised in a report by Messrs. A. Haller and H. Gault in the *Bulletin de la Société d'Encouragement* (vol. cix., No. 2). Commercial statistics show that as a result of theoretical chemical researches there has been equal progress in the manufacture of natural essences and in the preparation of artificial perfumes.

THE Engineering Standards Committee has issued a second report (No. 26; London: Crosby Lockwood and Son, price 10*s*. 6*d*.) of the locomotive committee on standard locomotives for Indian railways. Four additional types of locomotive have been included at the request of the Indian Railway Board, and at the request of the Secretary of State for India the locomotive committee has formed itself into a permanent advisory body.

AN address on the duration of the coal reserves of the United States, delivered by Mr. Marius R. Campbell to the National Geographic Society at Washington, is published in the *National Geographic Magazine* (vol. xviii., No. 2). He enumerates the coal areas of the various States, and shows that, while Pennsylvania produces the most coal, Montana has the largest coalfields. The total amount of coal in the United States, exclusive of Alaska, is estimated at 2,200,000 million tons. If the rate of consumption of 1905 were maintained indefinitely without change, this would last for 4000 years, but if the constantly increasing rate which has marked the consumption during the past ninety years be maintained, the coal supply will practically be exhausted within a hundred years.

MESSRS. F. VIEWEG AND SON have just published (pp. 417, price 12 marks) a fourth edition, revised and enlarged, of Prof. Albert Ladenburg's well-known "Vorträge über die Entwicklungsgeschichte der Chemie von Lavoisier bis zum Gegenwart," the first edition of which appeared so long ago as 1869. The main value of the work lies in the careful historical treatment of the progress of chemistry up to the time of the introduction of the conception of valency. To bring the account up to date, however, additional chapters have been written for the new edition dealing with recent advances in physical chemistry, and including the theories of mass action, heterogeneous equilibrium, tautomerism, stereochemistry, and solution; a review is also given of recent discoveries in organic chemistry. A special feature of this history is the very large number of references given to the original papers.

A THIRD edition of Prof. H. Röttger's "Lehrbuch der Nahrungsmittel-Chemie" has just been issued by the firm of J. A. Barth, of Leipzig (pp. xiv+901, price 16 marks paper covers, 17 marks bound). This work, probably for its completeness the most concise treatise on the chemistry of foods yet written, has gained in Germany a very high reputation, the second edition having been exhausted in a little more than three years. To the new edition a number of tables and an index of authors' names have been added, and a very complete set of references is given to the latest papers in all departments of the subject. Third editions have also been published by F. Tempsky, of Vienna, of Franz von Hemmelmayr's "Lehrbuch der anorganischen Chemie" and "Lehrbuch der organischen Chemie" (pp. 237, price 3 krone, and pp. 150, price 2·30 krone, respectively); these books are designed for use in the fifth and sixth classes of the Austrian Realschulen, and are of a purely elementary character.

SINCE the list of forthcoming scientific books appeared in NATURE of March 14, Messrs. Swan Sonnenschein and Co., Ltd., have announced that they have in preparation:—"The History and Ethnography of Africa South of the Zambezi, from the Settlement of the Portuguese at Sofala in September, 1505, to the Conquest of the Cape Colony by Great Britain in September, 1795," by G. M. Theal; "Thought and Things: a Study of the Development and Meaning of Thought or Genetic Logic," by Prof. J. M. Baldwin, 3 vols., vol. ii., "Experimental Logic," vol. iii., "Real Logic"; "The History of Philosophy," based on the work of Dr. J. E. Erdmann, fifth German edition, revised by Dr. W. B. Erdmann, edited by W. S. Hough; "Lectures in Humanism," by Prof. J. S. Mackenzie; "Mental Pathology and its Relation to Normal Psychology," by Prof. Storring, translated by Prof. T. Loveday; "Physiological Psychology," by Prof. W. Wundt, a translation of the fifth and wholly re-written German edition by Prof. E. B. Titchener, vol. ii.; "The Student's Textbook of Zoology," by A. Sedgwick, F.R.S., vol. iii., completing the work; and new editions of "Elementary Textbook of Practical Botany for the Botanical Laboratory and Private Student," by Prof. E. Strasburger, English edition by Prof. W. Hillhouse; and "Handbook of Mosses," by J. E. Bagnall.

OUR ASTRONOMICAL COLUMN.

COMET 1907*a* (GIACOBINI).—The results of numerous observations of this comet are recorded in No. 4162 of the *Astronomische Nachrichten*, wherein there also appears a set of elements communicated by Prof. E. C. Pickering. On March 11, at Vienna, Dr. Rheden found that the comet was of the eleventh magnitude, and had a diameter of 30″ with a central condensation.

No. 4163 (March 20) of the same journal contains a set of elements and an ephemeris computed by the discoverer of the comet, and, according to the latter, the position on April 4, at 12h. (M.T. Paris), will be

$$\alpha = 6\text{h. } 19{\cdot}5\text{m.}, \quad \delta = +1^\circ\ 8'{\cdot}5,$$

a point situated in Monoceros, and lying nearly half-way between ϵ Orionis and Procyon.

EPHEMERIS FOR THE MINOR PLANET (588) [1906 T.G.].—An ephemeris for the minor planet (588), extending from March 23 to June 19, is published in No. 4163 of the *Astronomische Nachrichten* by Dr. Bidschof. At present the planet is apparently in the constellation Leo, near to 91 Leonis, and is slowly travelling in a north-westerly direction; its magnitude is about 14·0.

SEARCH-EPHEMERIS FOR COMET 1900 III. (GIACOBINI).—A continuation of the ephemeris for the 1907 re-appearance of comet 1900 III. is given by Herr Scharbe in No. 4163 of the *Astronomische Nachrichten*. The ephemeris based on the assumption that perihelion passage will take place on June 8 extends from April 6 to May 16, and others, allowing for slightly different rates of motion of the comet, are also given.

THE SOLAR ECLIPSE OF JANUARY 13.—The most recent eclipse of the sun was observed as a partial eclipse at the Zi-ka-wei Observatory, and the results of the terrestrial magnetism, temperature, actinometric, and other observations appear in No. 1156 (March 23) of *Cosmos*. The magnetographs showed nothing abnormal, but, as shown by the curves which are given in the paper, there was a decided decrease from the normal, both in temperature and actinism. The former began to fall about fifteen minutes after first contact, and began to recover its normal value at about twenty-seven minutes after the maximum phase. An Arago actinometer was employed, and the effect of the moon's interposition was observed much sooner than in the case of the ordinary thermometer. The times of the first and last contacts and of the disappearances of several groups of spots were also recorded.

MAN'S PLACE IN THE UNIVERSE.—In an article appearing in the April number of the *Fortnightly Review*, Prof. Turner returns to the discussion of Dr. Wallace's views regarding the unique position of the earth in the universe. It will be remembered that Dr. Wallace advanced reasons for the belief that the earth was at the centre of the universe, and, occupying this unique position, was possibly the only inhabited sphere. But, as Prof. Turner now points out, the researches of Prof. Kapteyn and, more recently and definitely, those of Mr. Eddington (see NATURE, No. 1938, December 20, 1906, p. 182) have shown that we have to consider the question of *two* universes, and this renders Dr. Wallace's position untenable unless the assumption is made that the solar system is the centre about which both universes oscillate.

THE ASTRONOMICAL SOCIETY OF ANTWERP.—We have received the second annual report of the Société d'Astronomie d'Anvers, dealing with the work performed by the society during last year. This society was founded for the purpose of popularising the study of astronomy amongst the inhabitants of the town, and appears to be fulfilling its purpose in an exceedingly business-like manner. An observatory has been opened and is regularly used by the members, and, with the assistance of the city authorities, a course of free lectures on elementary astronomy is being given. The summaries of the first eleven lectures are published in the report, and these indicate that they should prove most instructive and worthy of emulation.

WIRELESS TELEGRAPHY IN LONGITUDE DETERMINATIONS.—A series of experimental determinations of longitude between Potsdam and the Brocken, made by Prof. Albrecht during 1906, has shown that wireless telegraphy may be usefully employed for this purpose between stations not connected by the ordinary telegraph. In this case the older method has been previously employed, so that the relative precision of the two methods may be compared. In general, the differences were found to be of the order of one-thousandth of a second, and were not modified by any variation of the amount of energy used. The duration of the transmission was negligible, but it was found that atmospheric influences were more effective than in the case of ordinary telegraphy (*La Nature*, No. 1765, March 23).

ANCIENT CHINESE ASTRONOMY.—In an interesting paper appearing in the *Revue générale des Sciences*, No. 4 (February 28), M. de Saussure discusses the astronomical records contained in an ancient Chinese canonical work dating back to before 2300 B.C., and from the discussion arrives at some striking conclusions concerning the antiquity of systematic astronomical observation in China. The chief conclusion is that prior to 2000 B.C. the Chinese possessed instruments and the complete theory of their equatorial astronomy, in which they presumably observed certain selected stars situated near to the equator, and from these observations deduced the apparent position of the sun, and hence the progress of the seasons. That the inhabitants of Britain and of Egypt possessed the astronomical knowledge and the means to attain the same end—although by somewhat different methods—at an equally early date has been already demonstrated by Sir Norman Lockyer.

PUBLIC HEALTH.

THE thirty-fourth annual report of the Local Government Board, 1904–5 (Supplement containing the Report of the Medical Officer, price 4*s*., London, 1906) commences with a useful summary of its contents by Mr. Power. Appendix A contains the provisions of the International Sanitary Convention of Paris, 1903, and of the West Indian Intercolonial Sanitary Convention, 1904, many reports by the Board's inspectors, statistical tables, and summaries by Dr. Bruce Low of the diffusion of plague and of cholera throughout the world in 1904. *Inter alia*, we are informed that vaccination is being increasingly adopted, the abstentions for 1903 being 14·7 per cent. of births as against 15·2 per cent. for 1902, and still higher for preceding years.

Appendix B contains the auxiliary scientific investigations carried out for the Board; Dr. Klein has investigated the transmission of plague in the rat, particularly by feeding. Feeding animals with cultures of the plague bacillus mixed with food having failed to infect, Dr. Klein conceived that if the organism were first protected from the digestive juices by drying it with the food, infection might occur; this was found to be the case, and in animals so infected the dejecta probably teem with bacilli. It was also found that earth or sand to which plague bacilli had been added in the form of gelatin cultures retained its infectivity for six to eight weeks.

Dr. Houston contributes a report on the bacteriological examination of deep well waters and of upland waters. The first section shows that *B. coli* is absent from 1000 c.c. of deep well water drawing its supply from distant and pure sources. The second section deals with the results of the examination of the waters of Loch Laggan and Loch Ericht (Inverness-shire). Loch Laggan is subject to a slight degree of pollution from human sources, Loch Ericht is not, and bacteriologically *B. coli* was contained in 10 c.c. in 33 per cent., and in 100 c.c. in 49 per cent., of Loch Laggan samples, while of Loch Ericht samples only 1 per cent. contained *B. coli* in 10 c.c. and 19 per cent. in 100 c.c. Dr. Houston therefore concludes that fish (of which the lochs contain abundance) and birds probably contribute little to the content of *coli*-like microbes, and that too stringent standards must not be adopted without topographical data.

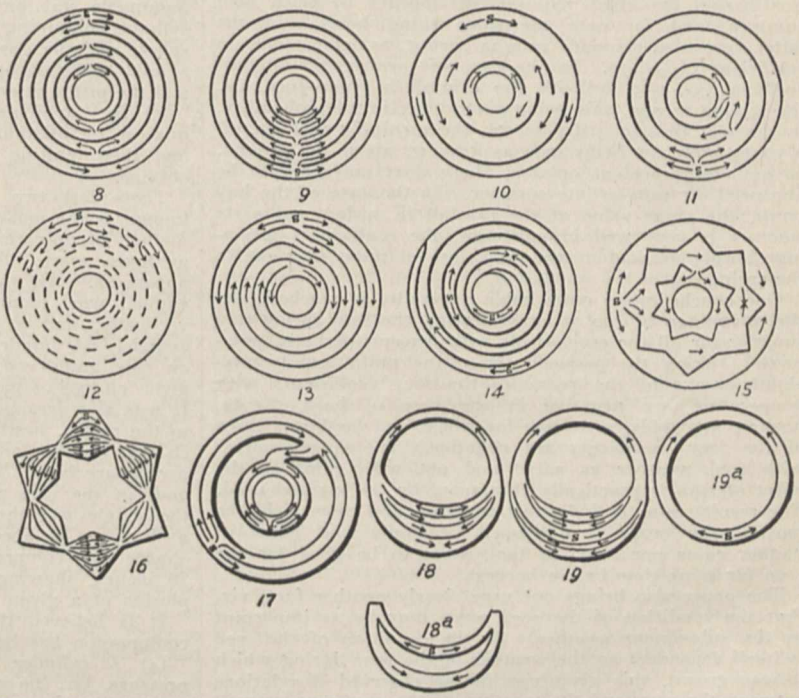
Dr. Sidney Martin has investigated the chemical products of the *B. enteritidis sporogenes*, but finds them to be without physiological action; also the specific agglutinins of various organisms.

Dr. Gordon has sought for a bacteriological test whereby particles shed from the skins may be detected in the air. He finds that a Staphylococcus (*S. epidermidis albus* of Welch, with certain attributes) is by far the most frequent organism of the skin, and another Staphylococcus of the scalp. Lastly, Dr. Alan Green records further experiments on chloroformed vaccine lymph and on the combined use of chloroform and glycerin in preparing lymph. The volume, therefore, contains much valuable matter, and is illustrated with a number of photographs.

R. T. HEWLETT.

PULSATION IN ANIMALS.[1]

JELLY-FISHES have been the subjects of frequent experimentation—we need only refer to the admirable researches of Romanes—and Mr. Alfred G. Mayer, director of the Department of Marine Biology of the Carnegie Institution of Washington, has been able to draw some new and exceedingly interesting general conclusions from a study of their pulsations. When the marginal sense-organs of the jelly-fish Cassiopea are cut off, the disc is paralysed and does not pulsate in sea-water. If a ring-like cut, or a series of concentric broken-ring-like cuts, be made through the muscular tissue of the sub-umbrella, the mutilated disc (without marginal sense-organs) responds to a momentary stimulus, *e.g.* a mechanical or electrical shock, or a single touch with a crystal of potassium sulphate, and suddenly springs into unusually rapid rhythmical pulsation. This is regular and sustained like clockwork, and continues indefinitely in normal sea-water without further external stimulation. The waves of pulsation all arise from the stimulated point, and the labyrinth of sub-umbrellar tissue around this centre must form a closed circuit—the stimulus being transmitted by the diffuse nervous or epithelial elements of the sub-umbrella. Any cut that breaks the circuit stops the waves of pulsation, and continuous movement cannot again be started. When each wave in a complete circuit returns to the centre it is reinforced and again sent out through the circuit. The centre once established remains a fixed point, while the disc continues to pulsate. The pulsation is fully twice as rapid as that of a normal Medusa, its rate varying with the length of the circuit, and it is self-sustaining (*i.e.* sustained by internal stimuli) once it be started by an external momentary stimulus.



Shapes cut from discs without marginal sense-organs. These will pulsate continuously in sea-water. The arrows indicate the paths of the waves of pulsation.

Mr. Mayer has endeavoured by numerous experiments to discover the *rôle* of the various salts in the sea-water, and he finds that the sodium chloride is the chief stimulant to pulsation in Cassiopea, while magnesium is the chief restrainer of pulsation, and counteracts the influence of the sodium chloride. Similarly, the heart of *Salpa democratica*, the heart of the embryo loggerhead turtle, and the branchial arms of the barnacle pulsate actively in solutions (*e.g.* Ringer's) containing only common salt, potassium and calcium, magnesium being absent. Magnesium inhibits pulsation in all these cases. Thus the general *rôle* of NaCl, K, and Ca in these cases is to combine to form a powerful stimulant producing an abnormally energetic pulsation, which, however, being exhausting, cannot continue indefinitely; and magnesium is necessary to control and reduce this stimulus, so that the pulsating organ is merely upon the threshold of stimulation. More concretely, the NaCl, K, and Ca of the sea-water unite in stimulating the pulsation of the jelly-fish, and in resisting the stupefying effect of the Mg, the general anæsthetic effect of which has been well known since the researches of Tullberg in 1892. All four salts conjointly produce in sea-water an indifferent, or balanced, fluid which neither stimulates nor stupefies the disc (*i.e.* the medusa with marginal sense-organs excised), and permits a recurring internal stimulus to produce rhythmic movement.

Not only has the author shown us a new method of restoring pulsation in paralysed Medusæ, but he has demonstrated that magnesium plays a most important *rôle* in restraining, controlling, and thereby prolonging pulsation in animal organisms. "Rhythmical pulsation can be maintained only when a stimulus and an inhibitor counteract one another, and cause the organism to be upon the threshold of stimulation; thus permitting weak internal stimuli to promote periodic contraction." Thus, once more, marine biology justifies itself in contributing to the progress of general physiology. J. A. T.

[1] "Rhythmical Pulsation in Scyphomedusæ." By Alfred G. Mayer. Pp. 62; illustrated. (Washington: Carnegie Institution, 1906.)

THE WEATHER AND THE CROPS.

AN interesting paper on the correlation between the weather and the crops, by Mr. R. H. Hooker, head of the statistical branch of the Board of Agriculture, was read before the Royal Statistical Society on January 15.

The subject is very fully discussed by the method of correlation, partial coefficients of correlation being determined between the produce of each crop and (1) the rainfall, (2) the accumulated temperature above 42° F. during successive overlapping periods of eight weeks (first to eighth weeks of the year, fifth to twelfth, and so on). The crops dealt with include wheat, barley, oats, beans, peas, potatoes, turnips and swedes, mangolds, hay from clover and rotation grass, and hay from permanent grass. As climatic conditions differ so materially in England and Scotland, and even in different parts of England, it was thought necessary to deal with a smaller area, and a group of eight

of the eastern counties was chosen for the purpose. The group includes the county with the largest acreage under each of the ten crops named, with the single exception of grass.

The results for wheat are of especial interest in connection with Dr. Shaw's conclusion as to the great importance of the autumn rainfall. Mr. Hooker confirms this, and finds, further, that the autumn is more important than any other period. The critical period is, however, probably somewhat shorter, the correlation of the produce with rain exhibiting a marked negative maximum for the thirty-seventh to forty-fourth weeks, the actual coefficient being −0·62; the coefficient with the rainfall of the cereal year as a whole is slightly greater still, viz. −0·69. There are two marked coefficients with the weather of the preceding summer, *i.e.* the summer of the year in which the seed for the crop was grown, viz. −0·49 with rain during the twenty-first to twenty-eighth weeks, and +0·51 with temperature for the twenty-ninth to thirty-sixth weeks, indicating absence of rain during the flowering period and warmth at harvest as necessary for good seed. For barley the chief requirement appears to be a cool summer, and for oats the same thing holds, but the latter crop also demands rain in spring, as indicated by a coefficient of +0·70. In the case of turnips, the highest coefficient, +0·55, is with the rainfall in June–July, *i.e.* the sowing season, this being partly due, in all probability, to the fact that in a dry season the turnip-fly will eat off a young crop almost as soon as it shows above the ground. In spite of prevalent opinion, there does not seem to be any need for rain in late summer. In the case of the hay crops, the great value of the rainfall in spring and early summer is very well brought out, the coefficients attaining sharply marked maximum values of more than 0·7 in the spring.

One conclusion of remarkable generality is reached, viz. the advantage of cool weather during the late spring and summer for all the crops dealt with (except, perhaps, potatoes). Taking the period between the ninth and twenty-eighth weeks of the year, all the four coefficients with temperature are negative in the case of barley, oats, turnips, mangolds, and hay; for wheat and for beans three of the four coefficients are negative. The correlation is with cool weather as such, and not with rain, as the effect of rain is practically eliminated by the method used. The result seems to indicate that grain and roots yield the most bulky crops if developed gradually and equably; neither rains nor heat, in fact, seem to be good for the crop for some time before harvest.

The paper also brings out very clearly another fact, viz. that the condition of the seed sown may be as important as the subsequent weather. As the condition of the seed is itself dependent on the weather of the year during which it was grown, this gives rise to the observed correlations between the crop and the weather of the seed year as well as that of the harvest year. Further, the meteorological conditions necessary for seed quality appear to be, broadly speaking, somewhat opposed to those necessary for a bulky crop. Thus, in the case of wheat, absence of rain during the flowering period and warmth at harvest were found to be necessary for good seed, but for a bulky crop cool weather is desirable. Considering all the coefficients with temperature for the ninth to thirty-sixth weeks, for wheat only one out of six is positive in the harvest year, five in the seed year; for barley none is positive in the harvest year, five in the seed year; for oats none in the harvest year, four in the seed year. This result would, by itself, suffice to account for the tendency observed in the case of cereals to an alternation of good and bad crops.

Although there is considerable uncertainty in some of the less well-marked results owing to the small number of observations available (twenty-one years), the application of the laborious methods used appears to have fully justified itself by the conclusions which have been thereby reached. How great the labour must have been may be judged from the number of correlation coefficients—between six and seven hundred—which have been tabulated by the author. The paper is published, with an abstract of the discussion which took place at the meeting, in the Journal of the Royal Statistical Society for March.

FLAME THE WORKING FLUID IN GAS AND PETROL ENGINES.[1]

FLAME produced by the combustion of inflammable gas or vapour and atmospheric air forms the working fluid of gas or petrol engines.

Mechanical power can be obtained by means of flame in several different methods:—

(1) By filling a vessel or cylinder with a mixture of gas and air, and igniting this mixture, a slight explosion is caused, and the excess pressure blows off through a valve. The temperature of the flame is very high, and so when it cools the pressure in the vessel is reduced below atmosphere. This reduction of pressure may be utilised by means of an engine operating by atmospheric pressure and discharging into a partly vacuous vessel, or by a piston moving into the vacuous vessel. This method may be called the explosion-vacuum method.

A modification of this method exists which may be called the flame-vacuum method. In it the explosion is dispensed with.

(2) By admitting a charge of atmospheric air and inflammable gas or vapour at atmospheric pressure to a cylinder containing a piston, cutting off access to the atmosphere and the gas supply, and igniting the mixed charge, a mild explosion occurs; the pressure rises in the cylinder, and the piston is driven forward to the end of its stroke.

(3) By supplying to a cylinder containing a piston a mixture of inflammable gas and air in a compressed state, and then igniting that mixture, a motive power can be obtained.

These last two methods, (2) and (3), are respectively known as the non-compression method and the compression method of operation in gas and petrol engines. The two methods were illustrated by a specially constructed apparatus. In this apparatus the cylinder of a petrol engine was mounted so that the piston reciprocated vertically, and a guide rod was fixed vertically on the cylinder. A hundred-pound weight was arranged to slide on this guide rod, and arrangements made by which a given charge of gas could be introduced into the cylinder. It was also arranged that the weight could be let down on to the piston, firstly so as to rest without compressing the charge, and secondly allowing compression of about 10 lb. per square inch. The mixture in the cylinder was ignited, and, in the case where the charge was not compressed, the weight was thrown up by the explosion and expansion a distance of about 10 inches. In the case where the charge was compressed, the weight was thrown up about 18 inches, showing clearly the increased effect of the explosion of a given charge when under compression.

It is believed that this is the first time the effect of compression has been shown as a lecture experiment.

(4) A cylinder is supplied with gas and air under pressure, but the mixture is ignited at a grating or shield as it enters the cylinder, and so the pressure in the cylinder never rises above the pressure at which it is supplied. The power here is obtained without any increase in pressure, and is due to the fact that a small volume of cool mixture, when inflamed, becomes a larger volume, so that although a pump may be used to compress mixture the expansion in the motor side is greater, although at the same pressure as the pressure in the pump.

These four modes of action were all illustrated by means of specially constructed apparatus, in which the effect of the working flame could be seen. The four modes of action, and combinations or modifications of them, include all the fundamental methods used in obtaining motive power from flame which have been attempted by mankind for the last hundred years. In the year 1820 the Rev. W. Cecil, of Cambridge, read a paper at the Cambridge Philosophical Society in which he described an engine which he had constructed to operate according to the explosion-vacuum method, and he states that at sixty revolutions per minute the explosions take place with perfect regularity. His engine consumed, he stated, 17·6 cubic feet of hydrogen gas per hour. He also mentions an engine operated in accordance with the second method, the non-compression explosion method, and one

[1] Abstract of a discourse delivered at the Royal Institution on Friday, February 22, by Mr. Dugald Clerk.

also operated by gunpowder. This paper gives an account of the first gas engine which appears to have been worked in Britain or elsewhere.

Six years later Samuel Brown invented and built an ingenious engine, depending on the flame-vacuum method, which appears to have been the earliest gas engine ever worked on any considerable scale. In an early number of the *Mechanics' Magazine* it is stated that Brown succeeded with his engine in propelling a boat upon the Thames and in actuating a road locomotive. This vacuum method, however, never produced a really commercial engine, its only survival being the small engine shown as illustrating a modified form of class (1).

Many engines have been built using the atmospheric, or, as it is more commonly known, the non-compression explosion principle, but the most successful was that of Lenoir. The simplest engine of this type was one which was used in considerable numbers until a comparatively recent date—the Bischoff engine. In it a mixture of gas and air is drawn into the cylinder through suitable valves. As the piston passes an igniting aperture the flame is sucked in, the mixture ignites, and a small check valve closes the flame or touch-hole aperture. In the Lenoir engine, which was the most successful of this type, however, many of the modern characteristics are found, such as the water-jacket and ignition by the electric spark. The gas consumption, however, of all these engines was very high, rather more than 90 cubic feet per indicated horse-power per hour. The power obtained for given dimensions, too, was very small.

The first and second methods accordingly are not now used. Their disadvantages proved too great. In all modern gas or petrol engines the third method is used, that is, the charge of inflammable mixture is compressed before ignition.

Many attempts to construct engines operating on the compression principle were made before success was obtained. In such attempts England had a full share. One of the very earliest feasible compression gas engines was that described by William Barnett, an Englishman, in the year 1838. This engine had many of the features of successful engines of to-day. Later proposals were made for similar engines, both in France and in Germany; but the first inventor to succeed in overcoming difficulties to a sufficient extent to produce a commercial engine was the late Dr. Otto, of Deutz. To Dr. Otto belongs the honour of producing the first successful compression gas engine. The great majority of modern gas and petrol engines operate on what is now known as the Otto cycle. The production of a compressed charge in a motor cylinder in a safe, quiet, and economical manner is a much more difficult problem than appears at first sight. Those of us upon whom fell the brunt of working out this problem about thirty years ago appreciate fully the ability and knowledge displayed by the late Dr. Otto in producing his famous engine. In the Otto engine the characteristic feature is found in the alternate use of the same piston and cylinder for the purpose of pump and motor. In one complete revolution the cylinder is used as a pump, and in another complete revolution as a motor. The cycle is very simple.

The Otto cycle has many great advantages. The charging and discharging of the gases is accomplished easily. The heat flow through the sides of the cylinder is not too continuous, and consequently the cycle can be operated at very high speeds. Many attempts, however, have been made to obviate the main disadvantage of the Otto cycle, that is, the necessity for two complete revolutions for every power impulse. In 1881 the lecturer invented a cycle of operations which gave in the same cylinder one power impulse at each revolution. This cycle is now known as the Clerk cycle, and it comes next to the Otto cycle in order of number of engines now running in the world. Sections showing the operation of the Clerk cycle were shown. Its characteristic consists of open ports at the outer end of the stroke, which are overrun by the piston. The pressure in the cylinder rapidly falls to atmosphere, and a charge is forced into the cylinder at low pressure, about 2 lb. above atmosphere. This displaces the exhaust products remaining in the cylinder, and furnishes the fresh charge, which is compressed on the return stroke into a space at the end of the cylinder. This charge is ignited, and in this way a power impulse is obtained for every forward stroke of the piston. A second cylinder is required in order to supply the charge. The second cylinder is very light in construction, both as to the cylinder itself, the piston, and the connecting rod and cranks driving it. Working sections of a Clerk engine and Lanchester engine were shown.

The last thirty years have seen the greatest development, so far as practical matters are concerned, so that now more than two million horse-power of stationary gas engines operated by flame are in use in the world. It is difficult to form an estimate of the power of motor-car engines in use, but probably it now exceeds a million horse-power.

Although great progress has been made in the practical control and utilisation of flame and gaseous explosions for the purpose of producing motive power, little is as yet known as to the actual properties of the flame-working fluid so utilised. Accordingly, for the present it is not possible to formulate a complete theory of the internal-combustion motor. The subject is a difficult one, and involves not only the statical properties of these gases, but requires a knowledge of the conditions and rate of chemical combinations occurring in minute fractions of a second, and of the conditions of dissociation of compounds such as carbonic acid and steam at high temperatures under varying conditions of temperature and pressure. Many distinguished investigators have given the subject some attention. Bunsen in 1866 arranged a small glass tube with a safety valve, and weights to apply pressure to the valve. He provided platinum points between which the electric spark could be passed the whole length of the tubular vessel. This vessel was filled with various explosive mixtures, and ignited by the spark. The valve was loaded until it just blew off. This blow-off pressure was considered to be the maximum pressure produced by the explosion. Bunsen's apparatus was very crude, and could not have been expected to give accurate results. The maximum pressures must have far exceeded the pressures registered by his apparatus. Messrs. Mallard and Le Chatelier, and Berthelot and Vieulle, took up the subject of gaseous explosions, and made experiments also with numerous gases and oxygen, and coal-gas and air. A series of experiments was made by the lecturer in 1883. A Richards indicator, of the best construction known at that date, was used, and secured indications which were fairly trustworthy. Curves of explosion and cooling with coal-gas so obtained were shown. These experiments also showed clearly that the whole of the heat present was not evolved at maximum temperature, assuming the gases to have their ordinary specific heat at the high temperatures as well as low. Messrs. Mallard and Le Chatelier, and Berthelot and Vieulle, had come to the conclusion that the specific heat of the gases had been changed, and they considered combustion to be complete at the maximum temperature, or nearly so. The lecturer's experience with engine indicator cards, supplementing the experiments made with gas and air mixtures in a closed vessel, led to the view that combustion was not complete, and that therefore it was not safe to draw deductions as to varying specific heat without quite definite knowledge that chemical combination was completed before determinations were made of specific heat value. The absence of definite knowledge as to specific heats at high temperatures, dissociation, and rates of continued combustion, made it impossible to develop any complete theory of the internal-combustion motor.

To enable some investigation, however, to be made on different engine cycles, it appeared desirable to consider the gas engine as an air engine pure and simple, operated with air of constant specific heat, the air being a perfect gas and the chemical action being assumed as merely a means of heating the air through the desired temperature range. Calculating on this simplified theory, it became evident that the efficiency to be obtained in an air engine without heat losses was dependent upon compression mainly. Working out this theory showed that while the utmost that could be theoretically expected from a non-compression engine of the Lenoir type was 22 per cent., compression supplied means of getting theoretical efficiencies as high as 60 per cent., with practicable ranges

of compressions. Considering, then, gas and petrol engines as air engines, the theory is very simple. There are three symmetrical cycles of compression air engines. It is interesting to note that for equal compressions it does not matter whether Carnot cycle, constant volume, or constant pressure engines be used—the theoretical efficiency is the same. It has been found in practice that a first-class modern engine operating on the constant-volume cycle will give in indicated power 0·7 of the heat which a perfect air engine would give under the same conditions of compression, proportions, &c. Thus an engine having an air-engine efficiency of 0·5 will give indicated work $0{\cdot}5 \times 0{\cdot}7 = 0{\cdot}35$, of all the heat given to it.

The air standard has proved its utility as a guide to the engineer for twenty-five years now, and has been adopted by a committee appointed by the Institution of Civil Engineers on the standards of efficiency in internal-combustion engines. To enable further progress to be made, however, it is now necessary to know more of the actual properties of the working fluid.

The earlier experiments made by the lecturer, and subsequent experiments made by Oliver in America, and by Messrs. Bairstow and Alexander in this country, were only in strictness applicable to the behaviour of highly heated gases in a closed vessel. No means of obtaining a cooling curve in an engine cylinder had been proposed.

At the beginning of 1905 the lecturer designed a new method, and made a considerable number of experiments on a 50-horse-power gas engine. By altering the valve arrangements of the engine so that when desired both inlet charge valve and exhaust valve can be held closed, diagrams were obtained from which a cooling curve was calculated.

In this method no gases are allowed to exhaust from the cylinder. The piston accordingly compresses the whole contents into the compression space, and the temperature which has fallen by expansion rises by compression. A point is touched on a vertical line from the end of the card. On expanding, a line below the first compression line is traced, then another compression line is obtained, and so on; a series of compression and expansion lines is obtained, each terminating under compression at certain specific points.

In this way a cooling curve is obtained which shows the real temperature drop upon the expanding and compressing lines. From this curve, by somewhat troublesome calculations, the mean apparent specific heat of the charge can be obtained for each expanding line. A curve of specific heats so obtained was shown.

These numbers give a very fair indication of the heat loss incurred in the cylinder, and the cooling curves show that for the whole stroke the mean temperature of the whole enclosing walls is about 70° C. when the water-jacket is cold and about 200° C. when the water-jacket is hot, but for the inner part of the stroke, the first three-tenths of the stroke, the mean temperature is much higher —170° C. when cold and 400° C. when hot.

This method of investigation gives a more accurate knowledge of the properties of the working fluid, so far as the thermodynamics of the engine are concerned, and it enables us to make an entire heat balance-sheet from the diagram only. Full-load diagrams taken from the engine have been examined by this method, and account for 105 thermal units, when the calorimeter shows 106 thermal units to be present. The method appears capable of very considerable accuracy.

Prof. Hopkinson has attacked the problem of heat loss to the closed vessel by another method, using a calorimeter by which the heat leaving the hot gases at any time is measured electrically, while at the same time the pressure is indicated. This arrangement promises to give important information as to the rate of loss in gaseous explosions, from which observations some deductions may be drawn as to specific heat and as to time of termination of combustion.

The lecturer is continuing investigations on various sizes of engines with a new form of optical indicator. An indicator card taken with this instrument was shown. The appearance of this indicator card is most interesting. There is slight discontinuity in the rising line, and just as maximum pressure is approached the indicator begins to oscillate rapidly through a small distance. These oscillations continue all down the explosion stroke, die out gradually, and do not terminate until the end of the compression stroke. The period of the oscillations is about 600 per second; the amplitude gradually decreases until it has practically ceased at the end of the first compression.

The period of the indicator is about 200 to the second, so far as ordinary piston displacement is concerned. From this it follows that considerable pressure disturbances within the cylinder must have occasioned the oscillation. In this particular engine, the explosion is always accompanied by a peculiar whistling sound, which seems to start just about the time the diagrams show the beginning of the oscillations, that is, immediately after ignition. It is somewhat difficult to account for this peculiar action, but it appears to have some connection with the discontinuous nature of combustion of a mixture of inflammable gas or vapour with air. This was illustrated by an experiment in which inflammable mixture was ignited at the open end of a long tube. The flame travels back along the tube, accompanied at first by a low, roaring sound, which increases in intensity as the end of the tube is reached, terminating in a loud snap. When this occurs, the flame flashes back again, and there is obvious oscillation of some kind proceeding. It is not known why the mixture flame burns in this way, but this particular roaring or whistling seems to occur only when combustion is going on, and is noticed in all pressure flames in the open air. It appears highly probable, then, that wherever this oscillation goes on combustion is still proceeding.

Experiments have also been made by Messrs. Holborn and Austen on the specific heat of air and carbonic acid by an entirely different method, and there is reason to hope that as a result of experiments which are progressing in this country and on the Continent the whole question will be cleared up in the next few years in a satisfactory manner.

As one who has given thirty years' study to the practical and scientific problems involved in this matter, it is exceedingly gratifying to find a great and increasing interest in the subject which will lead to the complete investigation of the complex properties of the working fluid.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. W. PEDDIE, lecturer in natural philosophy in the University of Edinburgh, has been appointed to the Harris chair of physics in University College, Dundee, in succession to Prof. Kuenen.

PROF. MIALL, F.R.S., who was appointed professor of biology in the Yorkshire College of Science in 1876, is retiring from his chair in the University of Leeds at the end of the present session. We understand that the council has decided to establish separate chairs of zoology and botany, and will shortly proceed to appoint professors of these subjects.

THE province of Saskatchewan is only eighteen months old, but already (says the *Times*) it is devoting its resources to the establishment of a State university. A Bill just introduced by the Provincial Government in the Legislative Assembly at Regina provides for the incorporation of such a university under a chancellor, convocation, senate, board of governors, and council. The number and nature of the faculties to be established will be decided by the university senate. The maintenance of the university is to be provided out of the general revenues of the province and also by a percentage of the net receipts of the province under the Succession Duties Ordinance.

THERE has been serious divergence of opinion for more than two years as to the policy of the Marine Biological Association of the West of Scotland. This association was founded in order, according to the first article of its constitution, to investigate the marine fauna and flora of the Clyde sea area, to maintain a biological station at Millport or other suitable locality, and generally to foster and encourage biological research. At the annual meeting of the association on March 27 an amendment was carried by a majority of one vote "that while approving generally

of the report, the meeting does not approve of the staff being employed in biological survey." The chairman, Dr. Rottenburg, Prof. Bower, Prof. Graham Kerr, Prof. Lawrie, Dr. Teacher, Mr. E. J. Bles, Mr. Todd, the honorary secretary, and other members of the general committee then tendered their resignations and withdrew from the meeting.

THE council of the Association of Teachers in Technical Institutions recently appointed a committee to report upon the mathematical syllabuses of the Board of Education, and the recommendations of the committee have been embodied in an "outline of suggested syllabuses" which has been sent by the council to the Secretary of the Board of Education. Several principles guided the council in drawing up its suggestions. It urges that there should be a progressive development in pure geometry, analytical geometry and analysis in each of the six stages into which the examinations of the Board are divided; that the six stages should give a homogeneous and comprehensive education in the main principles of the science; and that the course of work for honours examinations should be such as to place the student in a position to undertake original investigations should he desire to do so. It is a hopeful sign that teachers are able to lay before the Board of Education their views as to what it is reasonable and desirable to expect of candidates in examinations, and we have no doubt the Board will give the suggestions the consideration they deserve. Certain of the recommendations will be improved, no doubt, by submission to revision, but the cooperation of teachers with outside authorities in the examination of students deserves every encouragement.

ACCORDING to an address delivered by Miss Hoskyns-Abrahall in the Memorial Hall, Manchester, and published by the Manchester and Salford Sanitary Association, the system of popular education now current needs radical amendment in order to prevent further physical degeneration on the part of the lower-class population of the country. The system now in vogue is regarded as essentially non-hygienic, especially so far as infants and young children are concerned. The maintenance of silence and order in infant schools (formerly regarded as a piece of mental discipline) is condemned, and in lieu of this it is urged that the pupils should be put to play in a large empty apartment with "a heap of sand in one corner and a tub of water in another." It may be pointed out that much the same results could be attained without expense by allowing the children to play in the old-fashioned way in the streets or lanes. Nearly as drastic amendments are proposed in the curriculum for older pupils; while it is also urged that these should be kept at school until a considerably later age than is now the practice. Neither is the education of teachers anything like perfect, one of the elements lacking being "skilled observation of children and skilful handling of them in accordance with what has been observed."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 1. 1906.—"On Intravascular Coagulation in Albinoes and Pigmented Animals, and on the Behaviour of the Nucleo-proteids of Testes in Solution in the Production of Intravascular Coagulation." By G. P. **Mudge**. Communicated by Dr. A. D. Waller, F.R.S.

(1) When albinoes are injected with a solution of nucleo-proteid derived from a pigmented animal, a certain number of them, about 9 per cent., absolutely fail to clot, while about 7 per cent. give a qualified clotting, the remainder giving a typical intravascular coagulation of more or less extensive development.

(2) When albinoes are similarly injected with a solution of nucleo-proteid, but derived from albinoes, no absolute failure of coagulation occurs, and it is very doubtful if any qualified ones do. The great majority clot as distinctly as do pigmented individuals.

(3) When pigmented rabbits are injected with solutions of nucleo-proteids, derived from albinoes or with those derived from pigmented individuals, no failures of coagulation occur.

(4) The Himalayan rabbit, in respect of its reaction to injected nucleo-proteids, behaves like the complete albino. This rabbit, though resembling the Norway hare in its winter coat, in which condition Pickering failed to obtain intravascular coagulation, differs from it in having pink (unpigmented) instead of pigmented eyes, and in never becoming periodically wholly pigmented. It cannot, therefore, be used as corroborative evidence of Pickering's conclusion with respect to the Norway hare.

(5) Failures to coagulate, when they occur, are due to inherent qualities of the individuals and not to weakening in the activity of the solutions used.

(6) Albinoes require a larger mean dose per kilogram of body weight of injected nucleo-proteid to cause death by intravascular coagulation than do pigmented animals, the relative resisting powers of the pigmented and albino individuals being as 1 to 1·5 respectively.

(7) Both albino and pigmented individuals are more resistant to nucleo-proteids, obtained from individuals of their own race, than they are to those obtained from the alternative source.

(8) The activity of a solution of nucleo-proteid, prepared from spermatic glands, decreases (but not quite uniformly) as the maturity (weight) of the gland increases.

(9) Solutions of nucleo-proteids, prepared from heavier (maturer) spermatic glands, undergo a progressive loss of activity with increasing period of keeping, *i.e.* from one to twenty days. But solutions derived from lighter (immature) glands undergo a fluctuating variation in activity, falling off on the second day after preparation and rising again on the fifth to seventh, and thence exhibiting a progressive fall.

January 24.—"Note on the Application of Van der Waals's Equation to Solutions." By the Earl of **Berkeley**. Communicated by Prof. J. Larmor, Sec.R.S.

The author attempts to apply Van der Waals's equation of state to the results of direct measurements of osmotic pressure at 0° C. Various modifications of this equation were tried without success, but by the introduction of a third constant two equations were found that fit the experimental numbers.

The equations are:—

$$(A/v-p+a/v^2)(v-b)=RT \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$(A/v+p-a/v^2)(v-b)=RT \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where p is the osmotic pressure, R and T the gas constant and the absolute temperature respectively, while the v of equation (1) is the volume of water which contains 1 gram molecule of solute, and the v of equation (2) is the volume of solution containing the gram molecule.

It is pointed out that both equations give impossible values for the critical points; but on plotting the graph of equation (1) for the different substances, it is found that in each case the point at which $dp/dv=0$ and the osmotic pressure decreases with increase of concentration may be within the reach of experiment. Decrease of osmotic pressure with increase of concentration implies physical instability and change of state, hence it is suggested that when $dp/dv=0$ the limit of supersaturation has been reached, and the solute must crystallise out.

It is shown that a solution has two osmotic pressures; the second osmotic pressure (which would only be manifested directly if one could find a semi-permeable membrane permeable to the *solute*) is connected with the freezing point of the solution in a manner similar to that which connects the crystallising point and the ordinary osmotic pressure.

"On the Presence of Europium in Stars." By Joseph **Lunt**. Communicated by Sir David Gill, K.C.B., F.R.S.

Having obtained, from measures on the calcium line λ 4435·851 in the spectra of α Boötis and β Geminorum, radial-velocity values which were not in accord with those obtained from other stellar lines, the author suspected that the line near λ 4435·8 in the stars named was not a "pure" one. The resulting radial velocity was such as would be given by a "disturbing" line very close to the calcium line and at about λ 4435·753. Reference to records of laboratory spectra showed him that Exner

and Haschek gave a strong line of europium at λ 4435·75. A search for other strong europium lines in the Arcturus spectrum revealed several abnormally strong stellar lines agreeing closely in position with the europium lines, and the author concludes that these cannot be explained without involving the rare element in question. Incidentally, he reviews the evidence for the occurrence of the same element in the sun's chromosphere, and confirms Prof. Dyson's previous conclusions that europium is represented.

January 31.—"On the Discharge of Negative Electricity from Hot Calcium and from Lime." By Dr. Frank **Horton.** Communicated by Prof. J. J. Thomson, F.R.S.

This paper contains an account of some experiments in which the negative leak from hot calcium was compared with that from platinum and from lime under similar conditions. The negative leak from a platinum strip heated by an electric current was first investigated. This strip was then covered with metallic calcium by sublimation from an electrically-heated calcium wire situated in the discharge tube near to the kathode. The negative leak from the calcium-covered strip was determined at different temperatures. Some pure oxygen was then let into the apparatus, and the calcium on the kathode was oxidised to lime. The excess of oxygen was then removed and the negative leak again measured. Finally, hydrogen was let into the apparatus, and the effect of this gas on the negative leak from lime was investigated.

The results obtained may be summarised as follows:—

(1) The negative leak from calcium is greater than from platinum at the same temperature.

(2) On oxidising the calcium on the kathode to lime there is a great increase in the negative leak. This is contrary to expectation, for we should expect the presence in the molecule of lime of the electronegative atom of oxygen to act as an attracting force tending to retain the escaping corpuscle, and that consequently the leak from lime would be less than from calcium under the same conditions.

(3) The negative leak from lime in hydrogen is much greater than that in air or helium.

February 28.—"The Occlusion of the Residual Gas by the Glass Walls of Vacuum Tubes." By A. A. Campbell **Swinton.** Communicated by Sir William Crookes, F.R.S.

On strongly heating portions of the glass walls of vacuum tubes that had been subjected to severe use in 1898, and had since lain open to atmospheric pressure, they immediately became clouded, the effect being due to quantities of minute spherical bubbles of gas which could be clearly seen with a microscope, and were on the average about 0·01 mm. in diameter. By dissolving away one surface of the glass with hydrofluoric acid until the bubbles just disappeared, and measuring the thickness before and after this process, it was ascertained that the bubbles were about 0·122 mm. from the inner surface of the glass. It would therefore appear that the particles of gas must have been shot into the glass to about this depth.

In a typical case the number of bubbles per square centimetre was found to be about 625,000, from which it was calculated that the total amount of gas at atmospheric pressure occluded in the particular tube was nearly 0·05 cm. apart from any further amount that may have escaped on the heating of the glass.

A number of pieces of the glass were next placed in a flat and air-tight tin chamber connected with a vacuum pump and a spectrum tube. This was exhausted until no electric discharge would pass through the spectrum tube, and was then hammered so as to powder the glass. There was an immediate fall of vacuum, and on examination with a spectroscope the gas that had been evolved was found to be mainly hydrogen. This process was repeated several times, the result in each case being to bring out more hydrogen. It would therefore appear that the gas occluded in vacuum tubes exhausted in the ordinary manner from atmosphere is almost entirely hydrogen, due, no doubt, to the electrolysis of water vapour.

Further experiments were tried with helium. A new tube was first exhausted until no discharge would pass, and then helium was admitted in small quantities from time to time with intervening sparking, until 1 cubic centimetre at atmospheric pressure had been absorbed. The glass of this tube showed bubbles when heated, and on placing some of it in a vacuum chamber, as before described, and reducing it to powder, sufficient helium was evolved to show the helium spectrum clearly. Seeing that helium does not combine with anything at ordinary temperatures, and that this gas was extracted from the glass by mere mechanical powdering of the latter, it would appear that the occlusion is due to the mechanical driving of the gas into the glass, and not to any chemical combination.

Linnean Society, March 7.—Prof. W. A. Herdman, F.R.S., president, in the chair.—A series of specimens of *Nitella ornithopoda,* A. Braun, collected by the Rev. Canon Bullock Webster: H. and J. **Groves.** This rare species has only been found in a small district in the west of France, from Angoulême in the north to the south of Arcachon, and doubtfully in one locality in Portugal. The especial interest of the specimens exhibited, which were collected to the south of Arcachon in March and April, 1906, was that they represented gatherings of the plant from very different habitats, and showed great variations. The plants collected in shallow ditches were already in full fruit, while those from running water and from Lake Cazan were quite immature, and so far sterile. Only a few specimens of this species have previously reached England, and the collection exhibited was probably by far the most extensive series of forms yet obtained.—The ornamentation of the frog tadpole, *Rana temporaria,* tracing the growth of golden spots which attain a maximum about the thirtieth day after the tadpole emerges from its gelatinous envelope: Miss N. F. **Layard.**—Decapoda captured during the 1900 cruise of H.M.S. *Research* in the Bay of Biscay, forming No. xi. of the series of reports: S. W. **Kemp.** The majority of the specimens were larval, adult Decapoda, being as a rule strong enough to swim out of an ordinary tow-net. A fine series of stages of *Acanthephyra purpurea,* A. M.-Edw., showed that, as Coutière predicted, this species hatches as a Zoæa, while the allied *A. debilis* leaves the egg in a "post-larval" condition, with all its appendages formed. A curious feature of development was noted in that the rostrum and cornea, after considerable growth, undergo a sudden reduction, followed again by subsequent growth to the adult condition. The various stages, and those of a Caricyphus larva, were fully described and figured.—Colour changes in South African chamæleons, observed during the visit of the British Association to South Africa in 1905: Prof. E. B. **Poulton** and Dr. G. B. **Longstaff.**—The occurrence of *Spergularia atheniensis* and *Agrostis verticillata* in the Channel Islands: G. C. **Druce.**

Geological Society, March 13.—Dr. Aubrey Strahan, F.R.S., vice-president, in the chair.—A Silurian inlier in the eastern Mendips: Prof. S. H. **Reynolds.** The fragmental igneous rock is of two types:—(1) normal fine-grained tuff, from which in three localities more than thirty species of Silurian (probably Llandovery) fossils have been identified; the tuffs are seen at Sunnyhill to underlie the trap; (2) a coarse ashy conglomerate, the relation of which to the other rocks is obscure. Four possibilities as to the nature of this rock are discussed. It may be the basement-conglomerate of the Old Red Sandstone, an aqueous deposit belonging to the same igneous series as the associated trap and normal tuff, or an old river-gravel deposited subsequent to the fossiliferous Silurian and prior to the Old Red, or it may represent the necks of the volcanoes from which the rocks were ejected. The last of these possibilities agrees best with the facts.—Changes of physical constants which take place in certain minerals and igneous rocks, on the passage from the crystalline to the glassy state, with a short note on eutectic mixtures: J. A. **Douglas.** The author describes the electrical apparatus employed. Powdered rock of known specific gravity is fused as often as required in a loop of platinum ribbon. The fused product is powdered, examined with the microscope, and then placed in a diffusion column. The diffusion column is sealed in a glass tube. Acid rocks were found to increase 6 per cent. to 10 per

cent. in volume, intermediate rocks 5 per cent. to 7 per cent., and basic rocks less than 6 per cent. Of minerals tested, pargasite underwent the greatest expansion, albite gained 10 per cent., while in anorthite and leucite the increase was less than 4 per cent. The melting points of the rocks and minerals experimented upon were found to range from 1260° C. for rhyolite to 1070° C. for Clee Hill dolerite. The refractive indices of the glasses were determined in dense fluids. An attempt was made to find experimentally the eutectic proportions of quartz and felspar. A mixture of orthoclase and albite gave a melting point lower than those of either mineral taken separately.

Royal Meteorological Society, March 20.—Dr. H. R. Mill, president, in the chair.—The exploration of the air: Major B. F. S. **Baden-Powell.** Two classes of people are interested in the exploration of the atmosphere:—(1) the meteorologists, who study it chiefly to find out about the weather, and (2) the inventors, who would utilise it as a highway of travel. But these two are by no means rivals. The attainment of their objects will be of mutual assistance to one another. The aërial navigator will want to know all about the currents and the conditions of the air, while the meteorologist will derive the utmost benefit from the ability to visit any parts of the atmosphere. There are three means now at the service of man by which he may ascend into these desirable regions, or may send up self-recording instruments to probe the mysteries of the skies, viz. balloons, kites, and flying machines. The balloon, although at the time of its invention it was hailed with acclamation as promising the conquest of the air to man, yet it is now realised that this cumbrous and delicate apparatus is not capable of much practical application. It is, nevertheless, useful (1) as an observatory for scientific investigation, (2) as a means of reconnaissance in war, and (3) as a most agreeable way of spending an hour or two in blissful peace and sublimity. But recently great strides have been made in the improvement of the balloon in the way of providing it with engines and propellers so that it may be driven to any predetermined goal. Twenty-five years ago the French Government made the first dirigible airship, and now it possesses one, if not more, that seems to be a really practical air vessel of war. Count Zeppelin in Germany has also produced a machine which in point of size as well as in speed has beaten all records. Going to the other extreme, we have small balloons now capable of attaining the greatest heights carrying self-recording instruments. Such contrivances have recently ascended to the enormous altitude of 82,000 feet, or nearly sixteen miles above the surface of the earth. Closely connected with this subject of *ballons sondes*, as the French call them, is that of meteorological kites. These also have been much improved in recent years, and instruments lifted by kites retained by steel wires have actually ascended to a height of four miles. Kites of a much larger dimension have also come into use during the last few years. At Aldershot they have been regularly introduced into the service. Men were first lifted by this means in 1895, in which year the lecturer made a number of ascents up to 100 feet high, but improvements have gradually followed until now men have actually gone up to a height of 3000 feet, an elevation practically beyond the reach of rifle bullets, and so high as to render the aëronaut almost invisible. Major Baden-Powell, in conclusion, referred to a subject which, if it has not hitherto had any very practical results, yet promises to bring about perhaps more extraordinary changes in the life of man than have resulted from any other of the marvellous inventions of the nineteenth or twentieth centuries. The flying machine has come, and it has come to stay. During the last two or three years, not only have men been successfully raised off the ground, but have been able to sustain themselves in the air for half an hour at a time. Very little more remains now to be done before we can say that man has veritably conquered the air.

CAMBRIDGE.

Philosophical Society, February 25.—Dr. Hobson, president, in the chair.—Some points in the anatomy of the peripheral nerves: Dr. B. **Smith.** Several specimens were exhibited to show that the contour, size, and form of the nerve trunks of the body exhibited considerable variation; that these variations were associated with (i) the physical conditions of the tissue traversed by the nerve, (ii) the displacements and strains to which the nerve trunk was subject; that the local enlargements which certain nerves exhibited were due histologically to (i) an accumulation of the intrinsic connective tissue in the nerve trunk, (ii) the presence of numerous Paccinian corpuscles embedded in the nerve fibre bundles of the nerve trunk.—An occipital vermian fossa and cerebellar vermian eminence: Dr. G. F. **Rogers.** A median occipital fossa 14 mm. × 35 mm. in the shape of a gutter was shown with a series of varieties ranging from a small triangular flattening at the base of the occipital crest, through triangular fossæ of increasing size up to the specimen noted above.—The tendency to fusion shown by the suboccipital vertebræ: Prof. A. **Macalister.** A series of ankylosed cervical vertebræ in which there was exhibited a progressive coalescence of the several parts of the occiput and atlas, and of the axis and third cervical vertebra. The stages ranged from a simple adhesion to a complete unification. In one atlas there was a perfect neurocentral articulation between the pedicle and the axial odontoid process on one side.—The range of variation in the navicular bone: Dr. M. **Smith.** An exhaustive investigation of the very large collection in the anatomy school results in the distinction of several well-defined varieties of the navicular bone.—The histology of the early placenta in Semnopithecus: Dr. W. L. H. **Duckworth.** The anatomical department has received from Dr. C. Hose a specimen of the uterus of a *Macacus nemestrinus* in an early stage of pregnancy. Microscopic examination of the placental area gives valuable and suggestive information as to the mode of connection of the maternal with the embryonic tissues in the earliest stages of placental formation, showing in particular the fate of the uterine epithelial cells.—A chemical test for "strength" in wheat-flour: T. B. **Wood.** (See NATURE, February 21, p. 391.)—The application of integral equations to the determination of expansions in series of oscillating functions: H. **Bateman.**

March 11.—Dr. Hobson, president, in the chair.—Reduction of carbon dioxide to formaldehyde (preliminary note): Dr. **Fenton.** Experiments were performed which demonstrated the direct reduction of carbon dioxide to formaldehyde in aqueous solution. It was further shown that a similar reduction can be brought about indirectly, with formic acid as the intermediate stage.—Dithioxanthoxalanil and its homologues: S. **Ruhemann.** Thioacetanilide and its homologues react with ethyl oxalate in the presence of sodium ethoxide to yield coloured compounds; these, in composition, differ from the corresponding substances which the author previously obtained, on using acetanilide and its homologues, by the replacement of two of their oxygen atoms by sulphur.—Some observations on complex carbonates: T. B. **Wood** and H. O. **Jones.** The authors have investigated the solubility relations of potassium and copper carbonates, and determined the conditions under which the double salt, $K_2CO_3CuCO_3$, crystallises out from these solutions.—An optically active tetrahydroquinoline compound: F. **Buckney.** Experiments have been made on a series of derivatives of tetrahydroquinoline containing a quinquevalent nitrogen atom, but at present the only compound that has been resolved is methyl allyl tetrahydroquinolinium *d*-brom-camphorsulphonate. After repeated re-crystallisation of the *d*-brom-camphorsulphonate from ethyl acetate and toluene, the less soluble portion had a molecular rotatory power of 195° in aqueous solution, the value of $[M]_D$ for the basic ion consequently being $-75°$. The more soluble portion gave a value for $[M]_D$ of 342°. Hence the $[M]_D$ for the basic ion is $+72°$.—A series of substituted bromanilines: J. R. **Hill.** These compounds were prepared in order to obtain from them two series of asymmetric nitrogen compounds by the addition of allyl and benzyl iodides. Such series would only differ from those described by Miss M. B. Thomas and Mr. H. O. Jones (Journ. Chem. Soc., 1906, p. 280) by the presence of a bromine atom in the phenyl group. In this way the change in the optical activity produced by increasing the weight of the phenyl group could be studied. These

bromanilines were prepared by the bromination of the corresponding anilines; the series contains the bromophenyl and methyl groups with the ethyl, propyl, isopropyl, isobutyl, and isoamyl groups. The isopropyl compound is a solid; the others are oils. The bases were characterised by means of their picrates, and the quaternary compounds formed by addition of methyl iodide.—Some new platinocyanides: L. A. **Levy.** In continuation of previous researches upon the fluorescence of platinocyanides (Trans. Chem. Soc., January, 1906), the author prepared uranyl, guanidine, and nitron platinocyanides, which were briefly described.—The resolution of salts of asymmetric nitrogen compounds and weak organic acids: Miss A. **Homer.** With a view to find out whether optically active nitrogen compounds could be used for the resolution of weak organic acids, that is, for those cases where a strong base is required, tartaric acid was treated with a solution of phenyl benzyl methyl isopropyl ammonium hydroxide prepared from the iodide, equimolecular quantities of acid and base being used. A well-formed crystalline substance was obtained which on analysis proved to be the acid tartrate of the base used.—A new coloured fluorescent hydrocarbon: Miss A. **Homer.** A new hydrocarbon has been isolated from the products obtained by the action of aluminium chloride on naphthalene at 100° C., to which the formula $C_{26}H_{22}$ and the name tetramethyl erythrene have been assigned.—Notes on the proportion of the sexes in dogs: W. **Heape.** The results show a remarkable similarity in the proportion of the sexes born by greyhounds, collies, and large dogs as a whole, while in terriers there is sufficient difference from the above to show that distinct racial variation occurs. It is assumed from a variety of known facts that ova and spermatozoa are themselves sexual, and that the latest moment when the sex of the offspring can be determined is at the time of fertilisation.—Preliminary note upon the presence of phosphorus in crystalline egg albumin: Miss E. G. **Willcock** and W. B. **Hardy.**—The natural units of mass, length, and time: H. C. **Pocklington.**—The variation of the absorption bands of a crystal in a magnetic field: W. M. **Page.** An attempt is made to give a theoretical explanation of some observations made by M. Jean Becquerel in the behaviour of the absorption bands of certain uniaxial crystals in a magnetic field.

DUBLIN.

Royal Irish Academy, February 25.—Dr. F. A. Tarleton, president, in the chair.—The lower Palæozoic rocks of Pomeroy: W. G. **Fearnsides,** Dr. Gertrude L. **Elles,** and B. **Smith.** The paper gives an account of the application of the modern zonal methods to a district made classic by Portlock so long ago as 1845. The beds developed are divided into the Desertcreat group, the Little River group, and the Corrycroar group, and are the equivalents of the Ashgillian, the Llandovery, and the Tarannon groups of Great Britain. Of these the two lower groups are considered in detail, and are considerably subdivided. The Desertcreat group rests unconformably upon the ancient hornblendic and granitic rocks to the north, and is of a shelly or trilobite bearing type corresponding to the contemporaneous rocks of Girvan; its upper beds contain also a few graptolites and the interesting *Aeglina rediviva*. The Little River group follows conformably, and, like the rocks of Moffat, is wholly graptolitic. The rocks are much folded on the isoclinal plan, and the total thickness of the two groups mentioned can hardly exceed 600 feet. Notes on the correlation with other areas and descriptions of certain interesting trilobites are appended. The paper is illustrated by a map and sections.

DIARY OF SOCIETIES.

THURSDAY, APRIL 4.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Steam Traps: Gordon Stewart.

FRIDAY, APRIL 5.

GEOLOGISTS' ASSOCIATION, at 8.—On the Existence of the Alpine Vole, *Microtus nivalis*, in Britain during Pleistocene Times: M. A. C. Hinton.

MONDAY, APRIL 8.

SOCIOLOGICAL SOCIETY, at 4.30.—Research Meeting: The Problems of Cities: Prof. Geddes.

VICTORIA INSTITUTE, at 4.30.—Plant Distribution from an Old Standpoint: Dr. H. B. Guppy.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Observations on Cotton and Nitrated Cotton: H. de Mosenthal.

TUESDAY, APRIL 9.

ROYAL INSTITUTION, at 3.—Wings and Aëroplanes: Prof. G. H. Bryan, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Adjourned discussion*:—The Application of Hydro-Electric Power to Slate Mining: M. Kellow.—Electrically Driven Winding Gear and the Supply of Power to Mines: A. H. Preece.

ZOOLOGICAL SOCIETY, at 8.30.

WEDNESDAY, APRIL 10.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Bacterial Estimation of Phenol and Cresol: M. Wynter Blyth and L. Goodban.—A New Method for the Estimation of Tartaric Acid: Alfred C. Chapman and Percy Whitteridge.—The Detection of Cocoanut Oil in Butter: E. Hinks.

ENTOMOLOGICAL SOCIETY, at 8.—Odonata collected by Lieut.-Colonel Nurse, chiefly in North-Western India: Kenneth J. Morton.

SOCIETY OF ARTS at 8.—Arts and Industries in Hungary in Ancient and Modern days: L. Felberman.

THURSDAY, APRIL 11.

ROYAL INSTITUTION, at 3.—The Birth and Affinities of Crystals: Prof. Henry A. Miers, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, APRIL 12.

ROYAL INSTITUTION, at 9.—Conservation of Historic Buildings and Frescoes: Prof. A. H. Church, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—An Engineer's Visit to Japan and Canada: R. W. Allen.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Notes on New Zealand Polyplacophora, with Descriptions of Five New Species: H. Suter.—Descriptions of New Mollusca from New Caledonia: G. B. Sowerby.—Some New Species of Drymæus from Peru, Mexico, &c.: S. I. Da Costa.—A New Species of Vallonia from India: G. K. Gude.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Continued discussion*:—Petrol Motor-Omnibuses: W. Worby Beaumont.

SATURDAY, APRIL 13.

ROYAL INSTITUTION, at 3.—Studies in Magnetism: Prof. Silvanus P. Thompson, F.R.S.

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