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THE GREAT BARRIER REEF OF AUSTRALIA.

The Great Barrier Reef of Australia; its Products and Potentialities. By W. Saville-Kent, F.L.S., F.Z.S., F.I.Inst. 387 pp., 64 pls. (London: W. H. Allen and Co., Limited.)

THE first thought that strikes one in glancing through this magnificently illustrated volume is the diligence and skill of the author in photography and the enterprise of the publisher. Never before has a semi-scientific work been illustrated with such a wealth of plates. The illustrations will go far towards giving a realistic impression of some of the beauties of coral seas to the untravelled, and will awaken many recollections of happy hours of exciting shore collecting in those who have waded on coral reefs and peered over a boat-side at the edge of a reef.

The objects of the author in writing this book are set down in the Preface as being manifold—primarily to place before the reading public generally, and the scientific world in particular, more extensive and accurate information about coral-reefs as represented by the largest existing coral structure. Another prominent purpose is to lead to the industrial development of the "marvellous resources" of the Great Barrier Reef.

The book commences with a detailed description of over forty photographs of reefs and corals. These will well repay careful study, and to some naturalists they will be the most valuable portion of the work. The illustrations are unique for beauty, truthfulness, and number, and the descriptions are short and to the point. Two photographic plates and three sketches illustrate some groups of corals on the reef at Vivien Point, Thursday Island, of which measurements are given to furnish some data concerning the average rate of growth of the more important reef-forming species. The numerous plates of reef-scapes may possibly give the impression that coral reefs always present such scenes of interest and beauty, but the reader must be warned that it is only at low spring tides that he will see reefs as here photographed. At ordinary low tide the exposed surface of a reef is ugly and comparatively uninteresting. The amount of exposure to the fierce rays of a tropical sun which some corals can withstand will be surprising to many zoologists. In a few cases a future zoologist will be able to compare the *ad interim* growth or modification of a reef by the landmarks which appear in certain of Mr. Saville-Kent's photographs; but, unfortunately, little information of this kind is given, and it is still more to be regretted that the aspect of the area photographed is not recorded, there being no indication whether it is on the side of the steady south-east trade-wind or subject to the calms and storms of the north-west monsoon. It would further be of great interest if one knew why one reef or portion of a reef consisted almost solely of the genus Madrepora, while Porites characterises another area, or mixed corals a third.

The general reader is provided with the indispensable account of coral reefs, their general structure and theories of origin. This consists largely of appropriate quotations from other writers.

The third chapter is devoted "to a consideration of the general structure and most probable mode of origin of the Great Barrier Reef of Australia," the more notable features of the reef being described in order, beginning with the most southerly end. The view is enunciated "that coral-reefs are produced in the tropics, not with relation so much to the intrinsic reef-constructing properties of the specific coral polyps, but with relation to the rule that reef consolidation (or the amalgamation of coral *débris* into a more or less solid, coarse or fine, concrete, or into a finer-grained, compact limestone) is associated only with the rapid evaporation of the lime-saturated sea-water on inter-tropical, tidally exposed, coral banks or beaches." The presence of dead specimens of reef corals in Moreton Bay suggests two questions. Why did they not form reefs or reef-rock when they were abundant? and why have they now all but become extinct? Mr. Saville-Kent answers the first question by suggesting that the temperature of Moreton Bay is insufficient to produce the requisite rapid evaporation, and the second by pointing out that the increasing size of the three large islands which hem in the bay has latterly tended to freshen the bay in flood time, and this has led to the destruction of the corals. In his description of the Great Barrier Reef Mr. Saville-Kent has quoted largely from Jukes' "Voyage of the *Fly*" and thus endorses the accuracy of the observations of that distinguished naturalist. With regard to the question of subsidence and elevation, Mr. Saville-Kent found at many stations throughout the Barrier region (notably at Albany Pass, Cape York) large expanses of dead brittle coral *in situ* between high-water mark and the living banks. These beds of dead coral are now exposed to atmospheric influences which are antagonistic to coral growth with every ordinary springtide, and hence he concludes the general upheaval of the area on which it grew; additional evidence is given from the shallowing of a bay in Magnetic Island, near Townsville.

"It is difficult," Mr. Saville-Kent adds, "to associate the phenomena described in the foregoing record with any other than a movement of upheaval; but, accepting this as proven, and premising for the nonce that the whole length and breadth of the Barrier region exhibited a similar testimony of emergence, the amount raised, a foot or two only, would be as nothing compared with the latitude of movement in one direction or the other that is required to account for the construction of the Barrier's mass. Had the Great Barrier been fashioned during a prolonged epoch of upheaval, substantial evidence of such movement would be yielded by the strata of the seaboard which it skirts; but of this there is virtually none." Thus Mr. Saville-Kent supports the conclusion arrived at by Prof. Jukes and by the Reviewer that this is not an area of recent elevation. Mr. Saville-Kent refers to the well-known fact that all of the few big breaches in the Barrier's outer rampart are opposite large estuaries, though at the present time too remote from them to be influenced by their streams. These are to be expected on the subsidence hypothesis. Mr. Saville-Kent further elaborates an argument for this theory on the fauna of Tasmania and New Guinea being essentially similar to that of the respective neighbouring coasts of Australia and a more remote connection between New Zealand and Queensland through "Wallace's Bank." Mr. C. W. De Vis has recently identified some fossil bird bones from the Darling Downs (Queensland) as belonging to a true Moa (*Dinornis Queenslandiæ* n.sp.) to an allied genus (*Dromornis* n.g.) and to a near ally of the Kiwi (*Metapteryx bifrons* g.sp. nn.). This discovery is of such importance that it requires corroboration before it can be finally accepted by zoologists. It is unfortunate that on p. 137 occurs a foot-note in which the native name of an island in Torres Straits, "Moa," is associated with that of the extinct New Zealand bird. On the preceding page Dr. Wallace is quoted as saying that the complete disseverance of Australia and New Zealand was probably in the earlier portion of the tertiary period at least, and previous to this Mr. Saville-Kent himself says that "the very conspicuous racial distinctions between the human inhabitants of New Guinea, the Torres Strait Islands, and the Australian Continent, indicate that the separation of the districts must have been accomplished in prehistoric times, probably in a middle tertiary epoch."

While this statement of Mr. Saville-Kent's disproves his own suggestion, it cannot pass unchallenged. The Torres Straits Islanders are Papuans with probably, in some cases, an admixture of North Queensland blood, but anyhow, migration across Torres Straits is easy enough and does not require a land connection.

"Corals and Coral Animals" have a chapter to themselves. The classification adopted is not to be commended, and the term Zoantharia is restricted to the Zoantheæ, contrary to universal usage. Several new species of Actiniaria are described in general terms, and one new genus, *Physobrachia*, is erected for a polyp having "bladder-like apices of the tentacles." There is no evidence to show that this is a sea-anemone at all. The most remarkable form collected by Mr. Saville-Kent is a zoanthean which grows on an erect zigzag tube, about which there is a division of opinion; some zoologists regard it as an example of commensalism between an unknown annelid and a zoanthus, but Mr. Saville-Kent believes that the tube is secreted by the zoanthean, which he names *Acrozoanthus Australiæ*. The Reviewer finds that anatomically and histologically the polyp agrees precisely with other species of the genus Zoanthus. A rough sketch is given of *Platyzoanthus mussoides* Nov. gen. n.sp. which is insufficient for accurate determination; this is almost certainly a Hexactinian and not a Zoanthean, and probably it is *Rhodactis bryoides* H. and S., or an allied species. The section on the Madreporaria, or stony corals, is excellent, and the photographic illustrations of expanded corals are very valuable. The colours of the different species are described, and attention is drawn to the fact that not only may the same species, but in one case even the same individual varies in colour. The description of the Alcyonaria is valuable when confined to observations on the reef.

The chapter on "Pearl and Pearl-shell Fisheries" is chiefly intended for those interested in the commercial aspects of this important fishery, the average annual value of which is stated to be £69,000. The profits of the fishery are made out of the pearl-shell only, for though pearls, and often very valuable ones too, are frequent, they largely form the illegal perquisites of the native crews. Mr. Saville-Kent distinguishes two species, the large white shell *Meleagrina margaritifera* and a smaller black-edged form which he names *M. nigro-marginata* Mr. Saville-Kent has proved that it is possible to transplant living pearl-shell, and his experiments open up a prospect of the "shellers," as they are locally termed, forming nursery beds to which undersized shell can be transferred to be again taken up when they are better grown. The shells from these beds could be opened under the superintendence of the owners, who would then secure the pearls. The author is inclined to think that under favourable conditions a period not exceeding three years suffices for the shell to attain to the marketable size of eight or nine inches in diameter, and that heavy shells of 5lb. or 6lb. weight per pair may be the product of five years' growth.

The account of the "Bêche-de-Mer Fisheries" is one of the most workmanlike sections of the book. For the first time we can associate such terms as "prickly red" or "teat fish" with their appropriate scientific names. Twenty species of Holothurians are popularly diagnosed, of which six are described as being new species. As only the fully-grown forms are found on the surface of the reefs there is little fear of extermination through over-fishing.

A long chapter is devoted to "Oysters and Oyster Fisheries of Queensland," which is of more local and commercial than of general interest. Several species and numerous varieties of Ostrea are described and figured.

Two coloured plates and six photographic plates illustrate the chapter on "Food and Fancy Fishes," which will be of considerable value to local naturalists. A few new species are recorded.

The concluding chapter is entitled "Potentialities," and summarises in an able manner the vast store of food and wealth which is furnished by the Great Barrier Reef, and is still unappropriated.

There can be but little doubt if a serious fishery of the dugong is undertaken that interesting sirenian will soon become exterminated. It is not very evident why the "Great Barrier Reef sea-serpent" (*Chelosauria Lovelli*, n. gen. and sp.) should be placed among the potentialities of the Great Reef. A detailed description and sketches are given of a supposed enormous Chelonian, with snake-like head and fish-like tail. Dr. Günther, it appears, has offered "£100 for the entire animal, £50 for part, and a fair price for the head and neck sun-dried." An extensive fishery at these prices—for doubtless other curators would be willing to purchase—may perhaps be regarded as a possible, if improbable, source of wealth.

The author puts in a plea for a federal Australian marine biological station at Thursday Island in Torres Straits, which should "look for the main means of its foundation and maintenance to Australian corporate support and Australian private liberality." The Reviewer would like to add his testimony to the suitability of Thursday Island for this purpose. It is convenient from every point of view, being easy of access, with a regular mail and a telegraph, a safe anchorage, extensive and prolific reefs almost entirely surrounding the island, and inexhaustible reefs in the vicinity. Mr. Saville-Kent's book shows, as do also the series of papers by various experts, which are now being published by the Royal Dublin Society, that the fauna is one of extreme interest. A marine biological laboratory is one of those institutions in which, beyond all question, the interests of pure science and its applications to industry and commerce are so interwoven that there need not be any hesitation in endowing and supporting it by the most "practical" minded individual or Government.

There is evidence in the shape of numerous misprints that the author produced the book under stress of time. The systematic zoologist has a right to complain of Mr. Saville-Kent's practice of naming imperfectly diagnosed genera and species. In hardly a single case is there an adequate description of a new species. Being himself a zoologist, he should have been more considerate to his colleagues.

It is difficult to criticise the sixteen coloured plates which conclude the volume. They contain over two hundred colour sketches, selected out of a much larger number from the author's note books. This being so, we may regard them as colour memoranda, taken on the spot and grouped as plates. Very few of them can be regarded as drawings of the animals, since, as a rule, the critical points of form are omitted. The reviewer has checked the colours of some of the animals depicted by sketches made by himself of the same species, and he finds that Mr. Saville-Kent's colouration, or rather the lithographer's rendering of it, is accurate enough, but there is no doubt that the plates are very crude. Inartistic as they are, they serve to emphasise the glorious fauna of the coral seas. ALFRED C. HADDON.

BACTERIOLOGY FOR THE PUBLIC.

A Manual of Bacteriology. By A. B. Griffiths, Ph.D., F.R.S.E., F.C.S. (Heinemann's Scientific Handbook Series). Small crown 8vo. Illustrated. (London: Heinemann, 1893.)

THE number of bacteriological text-books is still comparatively so small, that each successive endeavour to expound the principles of this new science attracts more general attention than is occasioned by the appearance of similar treatises in sciences which have already an abundance of such works in circulation. It might be supposed that because bacteriology is a science of such recent growth it would be more easy to prepare a text-book of bacteriology, than one dealing with a science the literature of which extends over a much longer period of time. As a matter of fact, however, this is by no means the case, for probably in no other experimental science has so much to be taken on trust, owing to the impossibility of repeating investigations under precisely similar conditions, as can be done in the case of physics and chemistry; whilst again from the very juvenility of the science of bacteriology, there has not yet been sufficient time and opportunity for many of even the most important points to be firmly established through repeated observation by different investigators. On this account there is the more scope for the exercise of the judgment and critical faculty by the author of a work on bacteriology, and we are of opinion that a heavy load of responsibility rests upon the shoulders of a writer who undertakes to present o the public a worthy treatise on this important subject.

It is doubtless an appreciation of this grave responsibility which has deterred many well-qualified persons both in this country and on the Continent from publishing works dealing with more than comparatively small portions of this elastic and comprehensive science. The writer of the work before us plunges confidently into the task before him without even a moment's misgiving or hesitation; his preface does not contain a word which might betray any fear that the pages which are to follow may fail to do justice to "the important and far-reaching subject of bacteriology." The table of contents indicates that the information to be imparted in this little book of 348 small crown octavo pages, which are well printed in clear large type, is to be of a most comprehensive character. We find first, an introductory chapter, upon which follow the "bacteriological laboratory and its fittings," "methods of cultivating, staining, and mounting microbes," "origin, classification, and identification of microbes," "biology of microbes," "infectious diseases and microbes," "microbes of the air," "microbes of the soil," "microbes of water," "ptomaïnes and soluble ferments,' and lastly "germicides and antiseptics." To deal with this extensive material in such a small compass obviously requires that a very careful selection should be made of the matter which is to hand, in connection with each of the above divisions of the subject. The method of selection to be adopted in such a case must of course depend upon the kind of reader for which the book is intended, but this is a point on which we are not informed in the text nor on which have we been able to arrive at any conclusion from a perusal of the pages. The idea that the book is designed for the general reader is negatived by the fact that there occur long catalogues of bacterial species and of bacterial products, together with technical details which can only serve to increase the chaotic bewilderment in which the minds of most persons find themselves with regard to the subject of micro-organisms in general. On the other hand, for the serious student of bacteriology the information is as inadequate when detail is essential as it is discursive and wandering when terseness and precision are required. The entire work bears the impress of the hasty and premature compilation of undigested reading. We come to this conclusion, as it is almost impossible to believe that the author is so ignorant as some of his statements would indicate. Thus it would be uncharitable to believe that the author had written the following passage except by oversight: "Microbes may be simply divided into aërobic and anaërobic forms. *Bacillus spinosus* and *Bacillus œdematis maligni* are examples of the former; while *Micrococcus candicans* and *Bacillus subtilis* are examples of the latter kind." We feel sure that Dr. Griffiths is as well aware as the most elementary student of bacteriology that the *Bacillus subtilis* is a type of the aërobic and the *Bacillus œdematis maligni* a type of the anaërobic microbe. In the special description of *Bacillus subtilis* which follows in a later chapter we should be interested to learn on what authority this organism is described as "the hay-fever microbe." The same paragraph furnishes another excellent illustration of the kind of loose illogical writing in which this book abounds; thus, it is stated that "the action of ozone on both the spores and bacilli is that they are completely destroyed; this fact explains the absence of this and other microbes in the air at sea—the latter containing an appreciable amount of ozone." Innumerable experiments have surely proved that the absence of microbes in sea-air would be anticipated on mechanical grounds quite irrespectively of the possible subsidiary effect of ozone.

We believe that Dr. Griffiths is primarily a chemist, and a number of pages in this work are devoted to the chemical products elaborated by micro-organisms; in this connection we are informed that yeasts secrete a soluble enzyme which converts maltose into dextrose and levulose (*sic*), nor is it easy to believe that this is a *lapsus plumæ*, for the equation is given with the explanatory names beneath the formulæ, thus

$$\underset{\text{[maltose]}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{[dextrose]}}{C_6H_{12}O_6} + \underset{\text{[levulose]}}{C_6H_{12}O_6}.$$

Dr. Griffiths devotes a number of pages to the subject of hydrophobia, but in connection with the hitherto undiscovered vital cause of this malady we hardly think that either the public or the scientific world will feel much interest in the author's statement that he has "observed a micrococcus in the saliva of a woman suffering from hydrophobia," notwithstanding the categorical assurance which follows that "this microbe does not occur in healthy human saliva."

In dealing with the much-vexed subject of the etiology of pneumonia, the author refers only to the pneumococcus of Friedländer which has long been regarded as an ineligible candidate for the distinction of being the specific cause of this disease, whilst of the far more probable diplococcus of Fränkel there is no mention whatever, nor indeed of the uncertainty which surrounds the entire question.

Similarly, in connection with the bacillus of typhoid fever we find no mention of the closely-allied *Bacillus coli communis*, nor does the author appear to be acquainted with any of the modern methods which have been resorted to for its diagnosis, but contents himself with copying a long passage from Gaffky's original paper of 1886 in which the statement is made that the well-known potato-test serves to distinguish this microbe from all others. Indeed, the transcription of long passages from the works of other authors is a striking feature in this book, and inasmuch as such extracts are not printed in different type, the reader must be ever on the alert for the small inverted comma, in order to know whether he has before him the words of Dr. Griffiths or those of some more or less distinguished authority.

We do not think that any useful purpose would be served in pursuing this criticism further, nor should we have referred to as many points as we have done but that we have such strong reason to believe that the circulation of works of this kind among some sections of the public is fraught with no little danger. It is by no means uncommon for persons without any special qualification whatever, but with plenty of cheap assurance and a smattering of information gleaned from semi-popular works like the one before us, to perambulate the country under the auspices of county councils and other equally competent bodies, and to deliver discourses or even write books on sanitary and hygienic subjects; so that if the sources from which these retailers of third-hand knowledge draw are grievously inaccurate, it requires but little imagination to realise how serious may be the consequences.

THERMODYNAMICS.

Die Thermodynamik in der Chemie. Von J. J. van Laar. Mit einem Vorwort von Prof. Dr. J. H. van 't Hoff. Pp. xvi., and 196. (Amsterdam and Leipzig, 1893.)

TWENTY years ago the first application of the second law of thermodynamics to the study of chemical phenomena was published by Horstmann, and shortly afterwards the whole subject was investigated by Willard Gibbs, but in a manner so general that his work failed to gain the recognition of physical chemists for many years. Within the last decade, however, progress in this direction has been very rapid, and special branches or special aspects of chemical thermodynamics have received exhaustive treatment at the hands of van 't Hoff, Le Chatelier, Duhem, Planck, and others. But if we except the novel and brilliant exposition in the new edition of Ostwald's "Lehrbuch der allgemeinen Chemie," a general survey of the modern applications of thermodynamics to chemistry has hitherto been wanting, and it is to supply this want that Dr. van Laar has written the present volume.

The first half of the book is concerned with general thermodynamical principles and their application to the behaviour of gases and saturated vapours. The deviations from the laws of perfect gases are considered very fully—indeed, at inordinate length. As Prof. van 't Hoff says in his preface, the work is alternately text-book and memoir. Now, while this method of treatment may have its advantages, it entails an utter absence of balance between the various parts of the work. It appears, for instance, out of all proportion to devote a fifteenth part of the whole book to the discussion of the formula for the vapour pressure of a liquid. After making his way through thirteen pages of infinite series, differential equations, and determinants, the student finds that, when judiciously modified, van der Waals's equation can be made to express exactly the relationship between the temperature and pressure of a vapour in contact with its liquid—a result (to the chemist, at least) quite incommensurate with the trouble involved in arriving at it.

It is the second half of the work which is of special interest to students of physical chemistry. Beginning with the fundamental entropy principle of Gibbs, the author develops the various equilibrium equations, and gives a general proof of the important relation $d \log K/dT = Q/RT^2$. Then come applications to concrete cases of dissociation and balanced action. The "temperature of transformation" of phases of constant composition and the "triple point" are next fully discussed, and the last portion of the book is occupied with the behaviour of dilute solutions. Here the new theories of osmotic pressure and electrolytic dissociation are viewed from the thermodynamical standpoint, many important constants being calculated afresh. The depression of the freezing point and of the vapour pressure in solutions, as well as the question of affinity constants, all receive adequate treatment. In discussing neutralisation, however, the author has fallen into a serious error. On page 178 we find in italics the statement that "when a base and an acid are mixed in equivalent proportions in aqueous solution they are transformed entirely, no matter how weak they may be, into a salt and water." This is undoubtedly erroneous. A solution of potassium cyanide, for example, is never neutral, but always contains free potash and free prussic acid. The author has been led into this error by assuming in the construction of his equations that water is a perfect non-electrolyte, *i.e.* is not at all dissociated into ions.

The chief defects of the book are the want of proportion already alluded to, and the too bare formal mode of treatment. Fewer formulæ and more text would better suit the requirements of the average student. The typography and clear arrangement of the mathematical sections of the work are admirable. It is to be regretted, however, that the text has not had the advantage of revision by a German proof-reader. The Dutch compositor is presumably responsible for some quaint specimens of German, and oscillates in his spelling between antiquated forms like "dasz," "nähmlich," and painfully phonetic renderings such as "grafisch" and "Kwadratwurzel."

The book may be confidently recommended to those who already know the elements of thermodynamics and are desirous to learn the applications of that science to the problems of general chemistry. J. W.

OUR BOOK SHELF.

Discussion of the Precision of Measurements. By Silas W. Holman. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1892.)

THIS book deals with a subject that becomes more important every year, and its applications in nearly every science are both numerous and necessary. That our means of accurate measurement have reached a very fine stage, which is difficult to exceed, at any rate to a great extent, is well known, but results can be made of far greater value when subjected to a thorough discussion. In astronomy one may, perhaps, say that such discussions are carried through to their fullest extent and solving problems by the methods of least squares—a means of obtaining the most accurate values for the quantities sought after—is the rule and not the exception. To be able to find out the precision with which measurements have been made, whether by means of a yard-measure, the circle of a meridian instrument, or any other means, is at all times of great interest to the student of science, and the present work is intended especially as a course of study to engineers and for students of pure sciences, to present in a clear manner the principles on which such questions as, What accuracy is desired in the result? With what accuracy must each individual measure be obtained? and How trustworthy is the final result when obtained? &c., can be answered. The material here used is, as the author informs us, the outcome of several years' teaching of the subject, and a study of the volume itself indicates that he has presented it in a form that will commend itself to its readers. The book is divided mainly into three parts. The first deals with the treatment of direct measurements, the second with indirect, and the third with the determination of the best magnitudes of components. In the beginning the various sources of error, in different kinds of measurement, are pointed out, and the reader is made familiar with determinate and indeterminate errors, deviations, general laws of deviations, &c., terminating with two fully-worked out examples relating to the balance and voltmeter calibration. Part ii. gives in a clear way the methods of procedure with regard to indirect measurements, several examples being interpolated illustrative of the rules described. The third and last part is devoted to the solution of a certain class of problems, which deal more with the use of the instruments with which the observations are made, than with the observations themselves. Thus, for instance, in using a tangent galvanometer to find the best angle of the needle which will give the least errors of reading. This and several other problems, taking the cases when there are one, two, three, or more components, are thoroughly worked out. The book concludes with a series of illustrative examples.

Traité Pratique d'Analyse Chimique et de Recherches Toxicologiques. Par G. Guérin. (Paris: Georges Carré, 1893.)

THIS book differs in several important respects from ordinary works on analytical chemistry.

The first three parts are concerned with the ordinary processes of qualitative analysis—wet and dry reactions. the separation of group precipitates, &c. As special features of these sections it may be noted that coloured representations of borax beads and of beads of microcosmic salt are supplied, and that the reactions of the rare metals and of acids such as bromic, selenic, butyric, malic, meconic, &c., which are but seldom introduced into text-books, are fully discussed.

After a short section dealing with the qualitative analysis of gaseous substances, the author deals with spectroscopic methods of analysis. In this part are described the various forms of spectroscope, and the modes of obtaining and observing both emission and absorption spectra. A table is given of the characteristic rays in the emission spectra of the different elements arranged in order of their wave-lengths. In connection with absorption spectra, chlorophyll, salts of didymium and erbium, potassium permanganate, and blood, including the treatment of blood-stains, are considered. Both emission and absorption spectra are illustrated by means of coloured charts.

Part vi., which is by far the most extensive, is devoted to toxicology. The conduct of chemico-legal inquiries in cases of suspected poisoning by arsenic, phosphorus, hydrocyanic acid, chloroform, and chloral are first given in detail. Then are considered the general reactions and, where devised, the modes of separation of the vegetable alkaloids and the alkaloids of animal origin, the ptomaines and leucomaines. This section is completed by a full and historical account of the characteristic chemical properties and physiological action of the principal alkaloids.

Quantitative methods only find a place in the last part of the book, where the author introduces the examination of potable and mineral waters, and the estimation of clays, irons, and steels. In this part the apparatus and methods used in the bacteriological study of water are also included. An appendix relating to the preparation and concentration of reagents and a full index are supplied.

The prominence given to the reactions of the rare metals, the introduction of spectroscopic methods, and in particular the chapters on toxicology, make the work a valuable addition to the literature on analysis. It may be noted, however, that when dealing with the constitution of substances like the alkaloids, the author occasionally uses formulæ which are as yet far from being definitely established.

LETTERS TO THE EDITOR.

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Identification.

PERMIT me to make in your columns a few remarks on the following topic:—

It is now well known that the Council of the British Association have lately memorialised the Secretaries of State for the Home Department, Army, Navy, India, and the Colonies, expressing an opinion that the Anthropometric methods for Identification in use in France and elsewhere, deserve serious inquiry, as to their efficiency, the cost of their maintenance, their general utility, and the propriety of introducing them, or any modification of them, into the Criminal Department of the Home Office, into the Recruiting Departments of the Army and Navy, or in the Indian and Colonial Administration.

In connection with this suggested inquiry I have some very recent information to give as regards the inclusion of finger prints among the records that admit of being usefully employed in *bertillonage*. This convenient term has been coined to express the principle of the French system, invented and directed by Alphonse Bertillon, of so classifying anthropometric records that each can be sorted into its own natural group, just as each surname falls into its alphabetical place in a common directory. There may be many Smiths, but every Smith will be found among the Smiths and not among the Browns. There may be doubt about the exact spelling, and the Smythes will have also to be searched, but the range of uncertainty as to where to look for the required name will always be narrowly limited. So it is with the ordinary anthropometric records; so also it is with finger prints, which are as yet unused in the French system. Those who have read my book on the subject will recollect that the index letters for finger prints are limited to *a, u, r*, or *w*, as the case may be, for the two fore-fingers, and *a, l, w*, for the remaining eight digits. These produce such combinations of ten letters as *ral, ull*; *wl, ll*, which are arranged alphabetically. The test of the efficiency of this system lies, *first* in the sureness with which different (instructed) persons assign the same index letters to the same indifferently printed set, and *secondly* in the degree to which the sets are differentiated by their classification. Now I possess and have examined some thousands of well printed sets of students and others at my laboratory; but until very recently I had no large collection of *ill*-printed sets of *prisoners*. This want has been at length supplied in the following manner, by which I am able to confirm previous conclusions. Lieut.-Col. Surgeon Hendley, whose energetic furtherance of science and art at Jeypore is well known, was in charge last year of the Maharajah's magnificent contribution to the Imperial Institute, and, having visited my laboratory, became much interested in finger prints, and promised to send me a collection taken from the gaols of Jeypore. It arrived not very many days ago, too late to be alluded to in my recently issued supplementary chapter on the Decipherment of Blurred Finger Prints. It contains nearly a thousand cards, each card bearing the impressions of all the ten digits of a different person. They were printed by pressing the finger first on the pad used for inking the office stamp and then on the card. This method, as I have recently had occasion to point out, gives far inferior results to that of printers' ink. So far as the Jeypore collection shows favourable results, a similar collection printed in the way always used in my laboratory would give still better ones.

Consequently, the Jeypore collection is particularly serviceable for arriving at moderate conclusions; moreover, their number is sufficiently large to justify them. My assistant marked the appropriate index letters on each card, and I compared them with my own independent determinations. The result was very favourable; our readings practically agreed, and although most of the prints were faint, or blurred, or otherwise imperfect, it was possible to classify nearly all of them. This affords a strong confirmation to my formerly expressed belief that the method of finger prints must, in time, come into use as an important and supplementary aid to *bertillonage*. The process of taking the impressions is extremely simple after it has been learnt and the small but necessary equipment is at hand. At the same time, there is no undressing necessary, and nothing else of a humiliating character to be undergone during the brief act of making the prints.

I shall not here enter upon the unique and extraordinary power of finger prints in enabling us to determine, irrespectively of age and growth, whether two clear impressions, taken at different dates, were or were not made by the same finger. It does not depend on that general pattern of the print which is the basis of classification, but upon the numerous forks and other details in the ridges that compose the patterns. This has been fully discussed and proved in my two books, and I have nothing new to say, except that in my laboratory I have now upwards of 300 complete duplicate sets to work upon, the two members of each of which were taken at times separated by various intervals ranging between one and three years. These intervals are too short to be of much value, but the collection will increase in importance as the years go by, and further repetitions of prints from the same fingers shall have been made.

My letter is already long, so perhaps you will permit me on another occasion to recur to the action of the Council of the British Association, and to indicate the character of the information regarding the efficiency, cost, and utility of *bertillonage*, that might be gained with little trouble officially, but which is almost beyond the reach of any private person to obtain.

FRANCIS GALTON.

The Publication of Physical Papers.

MR. SWINBURNE in his letter on this subject has omitted to recognise the existence of a society which is older and quite as important as the Physical Society, I mean the "London Mathematical Society."

For reasons which it is unnecessary to enter into, I fear that an impression has unfortunately got abroad that the London Mathematical Society is an institution which exists solely for the advancement of *pure* mathematics. No greater error could be made; for whatever may have been the case in the earlier days of the society, the council for some years past have been fully alive to the importance of doing everything they can to encourage mathematical physics, and to induce physicists, whether members of the society or not, to communicate papers on mathematical physics. In short, the policy of the council at the present time is to endeavour to hold the balance evenly between the two branches of mathematics, and not to favour the one more than the other.

The policy of the society is still further exemplified by the fact that on the last two occasions the De Morgan medal has been awarded alternately to a mathematical physicist and to a pure mathematician; and during the discussion which took place in connection with the last award to Prof. Klein, several members of the council expressed a hope that this practice would be followed in future years.

A scientific newspaper like NATURE is scarcely suitable for the publication *in extenso* of papers relating to mathematical physics; but it may be well to point out that the London Mathematical Society presents contributors of papers with twenty-five *gratuitous* copies, whereas the proprietors of the *Philosophical Magazine* refuse to present gratuitous copies or to remunerate contributors in any way whatever. Moreover, the Proceedings of the Society can be purchased by the public, whilst (according to Mr. Swinburne) those of the Physical Society cannot. Also abstracts of papers read at the meetings of the London Mathematical Society can always, if the author wishes it, be published in NATURE, and can thus be at once brought before the notice of the scientific public.

It will thus be seen that the London Mathematical Society offers greater advantages to contributors than the Physical Society or the *Philosophical Magazine*; and when this fact is once recognised I venture to hope that physicists will not stand aloof from the Society in the way that many of them have hitherto done.

A. B. BASSET.

A Simple Rule for finding the Day of the Week corresponding to any given Day of the Month and Year.

MR. H. W. W., in NATURE, vol. xlvii. p. 509, gives a simple rule for finding the day of the week corresponding to any given date. It seems that this rule could be made still more simple. Thus, let

A = number of the given year.

B = number of the day in the year.

C = number of leap years from A.D. 1 to the beginning of the given year—viz. $(A-1) \div 4$, neglecting the remainder. Add these numbers together, and from the total subtract D = the number of secular years, which were ordinary years (100, 200, 300, 500, &c.). The sum is then divided by 7, and the remainder is the day of the week.

Example: June 18, 1815. $1815 + 169 + 453 - 14 = 2423 \div 7$. The remainder = 1. Therefore the day is Sunday.

This method holds good for any century according to the Gregorian Calendar. For the Julian reckoning, the rule is the same, only we must omit the number D, and write -2 in its place. The rule is then good without any change for any century.

Example: Oct. 14, 1066. $1066 + 287 + 266 - 2 = 1617 \div 7$. The remainder = 0 = 7th day, Saturday. C. BRAUN.

Mariaschein, Bohemia, June 15.

The Fundamental Axioms of Dynamics.

PROF. LODGE (NATURE, p. 174) maintains, in opposition to my correction, that your report of his recent paper on dynamical axioms was accurate in making the following statement:—"Dr. MacGregor objects to the author's definition of energy as the name given to 'work done,' and contends that this definition assumes conservation." He cites in proof the first two pages of my paper in the February number of the *Phil. Mag.* These pages, however, contain no reference to this definition, but a discussion of his definition of energy as *the effect of work done.* The definition of energy as a name given to work done is discussed on the fourth page, where the following will be found:—"In a second version of the above argument Newton's third law and contact action *are the only assumptions made* . . . The definition of energy in this argument is quite different from that of the earlier paper:—'Energy is that which a body loses when it does work; and it is to be measured as numerically equal to the work done.' There is here no reference to working-power. Loss of energy is simply a synonym for work done by, and gain of energy for work done on."

J. G. MACGREGOR.

Royal Society, Edinburgh, June 23.

Artistic Rows of Elms.

IN your Notes, p. 182, June 22, you say that "a correspondent desires to know where to find any celebrated and artistic hedgerows of elms within about thirty or forty miles of London."

If he will travel down to Sittingbourne, which is about forty-five miles by rail, and five miles less by road, from London, he can see some fine elms on the south and west bounds of the Murston Rectory Pastures, locally known as the Park.

The southern toll of elms is a triple row about 130 paces in length, the western toll of elms is on Gaze Hill, and is a double row about 212 paces in length. These elms must have been planted before this century. Being on elevated land they are well seen from considerable distances in the neighbourhood. Singularly enough they do not belong to the glebe. The southern toll, however, belongs to the patrons of the living, and the western toll to my predecessor, the Rev. J. S. Hoare, who purchased them, with the land they stand on, from the late Mr. Twopenny, of Woodstock, Tunstall. I have not yet been able to persuade the patrons of the living to purchase them from the present owner. ALEX. FREEMAN.

Murston Rectory, Sittingbourne, June 27.

Soaring of Hawk.

THE rest-house in which I now am stands close to the edge of a precipitous descent. There is a covered verandah in front, and we are nearly 9000 feet above the sea. I have just seen a hawk, or vulture hawk, circle round three times over the precipice. The whole time its wings were motionless (to the sight). Its first circle was on a level with me, the second was higher, the third was unquestionably higher still. As I sat I could see both the complete first and second circles. To see the last I should have had to go to the edge of the verandah. This appears to be a clear case of rising circles without (apparent) motion of the wings. I have seen the same thing from the plains, but have not been so sure of the fact observed. There is a light wind blowing, scarcely moving the trees.

The part of the circle near me was, in the first and second cases, within a few feet of where I sat, the third was *over* the roof of the verandah, and out of my line of sight.

Changla Gali, May 25. F. C. CONSTABLE.

Carrier Pigeons.

PROF. MAREY states in his "Animal Mechanism," p. 214, "that a bird which has traversed in a single flight a distance of fifty leagues (which it seems to do without taking any food) weighs only a few grammes less than at its departure." I shall be grateful to any of your readers who will inform me where evidence of this is to be found. The enormous amount of food consumed by birds would seem to show that the processes of loss and repair go on in their bodies with great rapidity.

F. W. HEADLEY.

Haileybury College, Hertford, June 27.

A Method of obtaining Glochidia.

THE Glochidia of Anodon are not always easy to obtain. They appear to be retained, and shed only when fish are swimming near.

Tadpoles have the same influence as fish, and a good supply of Glochida may be obtained by examining the tails of tadpoles swimming in a dish in which a few Anodons have been placed.

G. P. DARNELL-SMITH.

60, St. Michael's Hill, Bristol, June 26.

A NEW STATUE OF ARAGO.

IN this country the prevailing opinion is that the works of a man of science furnish the best monument to his memory. Though something can be said in favour of that principle, the restriction of its application to students and interpreters of nature is by no means justifiable. But a "look around" at the statues, and tablets, and other marks of public appreciation, shows that a man's greatness is, in general, not measured by his scientific labours. They do these things better in France. Those who honour a man and his works desire to proclaim his fame in the market-place, so that all may know that he was a giant among men. Passers-by are thus brought to a knowledge of deeds that they wot not of, and they see that a life devoted to science is one to be emulated. Thoughts of this kind forced themselves upon us when it was announced a few weeks ago that a statue to Arago had been unveiled in Paris.

Fourteen years ago a statue to Arago was erected at Perpignan, near his birthplace, and in 1886 it was decided to commemorate the centenary of his birth by raising the funds for erecting a statue at Paris. A committee, having the late Admiral Mouchez for its president, was then formed, and an appeal for subscriptions was made. Thanks to the contributions from the State and the Municipal Council of Paris, the necessary money was soon raised, and M. Oliva was commissioned as the sculptor. The statue has been completed for some time, and it would have been unveiled last summer but for the death of the artist, and later, of Admiral Mouchez, who was the prime mover in the matter.

The inauguration of the statue at the back of the Paris Observatory took place under M. Poincaré, Minister of Public Instruction, on June 11. Among those present were M. E. Arago, French Ambassador at Berne, and son of the renowned astronomer; M. Tisserand, the director of the Paris Observatory; M. Cornu, M. Huet, representing the Prefect of the Seine; and M. Muzet, vice-president of the Municipal Council of Paris. Each of these gentlemen dwelt in eulogistic terms on the career of Arago as a public man as well as a man of science. "Arago introduced physics into astronomy," said M. Tisserand, "and gave it a permanent place. Before him, astronomers concerned themselves chiefly with the movements of stars and members of our planetary system, seeking to explain them in their minutest details by the law of gravitation. Arago studied the nature of heavenly bodies, and the character of the phenomena continually exhibited by them. The polariscope showed him that the glaring surface of the sun is gaseous, and gave him important information as to the light of comets. Another application of physical methods furnished him with a precise means for measuring the diameters of planets or determining their magnitude. Nothing is more ingenious than his explanation of the scintillation of stars, founded upon the remarkable properties Fresnel found to be possessed by rays of light. Arago ought truly to be considered as the founder of a branch of astronomy—physical astronomy—that has since been remarkably extended, for it was he who pointed out the importance that would accrue from the application of photography to the study of celestial bodies. He was not able to foresee the day, however, when chemistry would enter into the domain of astronomy, and we should be able to discover their constitution; spectrum analysis has only been discovered, in fact, since the death of Arago."

"An example will give an idea of the perspicacity of Arago. It is generally known that about the end of last century France took the initiative of the metrical system and made it an international thing by connecting the metre with the size of the earth. But our globe is cooling and contracts, little by little, in the course of centuries, so that the unit of length is rendered liable to slight changes. Arago thought that a minute study of the light-rays that come to us from the sun and stars might furnish a rigorously constant unit of length, connected not with the earth, but with the stars—a sidereal metre of some kind. Well, this beautiful idea was realised a few months ago by Mr. Michelson, at the American Bureau of Weights and Measures." M. Tisserand also dwelt upon the influence that Arago exercised upon his pupils and the comprehensive character of his literary works. M. Cornu followed with an account of Arago's investigations in experimental physics, and after stating his work in connection with the *experimentum crucis* of the emission and wave theories of light, said, "If we come to terrestrial physics, meteorology, or industrial applications of steam and electricity, we always find Arago in the front rank with new ideas. Of an indefatigable activity, in science as in government, he was present with all the resources of his powerful spirit, with the ardour of his generous heart, especially where there was a great work to direct, a just cause to defend, a social evil to fight, and, at the call of duty, a peril to face."

The character of the statue, which is in bronze, is shown in the accompanying illustration from *La Nature*. Arago has his face turned towards the observatory. The pedestal on which the figure stands is also in bronze, and bears the simple inscription "François Arago, 1786–1853. Souscription Nationale." Men of science throughout the world respect the name, and their French *confrères* revere it. Those who have done homage to the man by thus assisting to perpetuate his memory are themselves honoured in the act.

MODERN MYCOLOGY.[1]

It is not often that a great and industrious investigator lives to see his chief work so far completed as Prof. Brefeld has done; and still more rarely to find an enthusiastic exponent of all his views so willing and so capable of putting them before the public as Dr. von Tavel here proves himself to be.

It is hardly thirty years ago since the late Prof. de Bary of Strasburg showed that the study of the fungi, up to that time a chaos of statements in which the student usually lost himself hopelessly, was capable of being made not only a very scientific and important branch of Botany, but also a very interesting one, and that there were already workers in the field—especially the Tulasnes—who were showing how to do this, by patient and thorough investigations of each species that could be properly studied.

De Bary himself founded a school of exact inquirers,

[1] "Vergleichende Morphologie der Pilze." By Dr. F. Von Tavel (Jena: Fischer, 1892.)

whose brilliant discoveries on the nature of parasitism and the development of the fungi, and above all, the propounding and testing of intelligent theories to explain the facts observed, will never be forgotten.

Brefeld was driven, at an early period of his investigations, to differ entirely from De Bary regarding a fundamental point in the morphology of the fungi. Certain organs discovered by De Bary in the simpler ascomycetes were regarded by him as morphologically sexual organs, and in later years the doctrine of the sexuality of the fungi became a central pivot around which the whole question of the morphology and evolution of these remarkable cryptogams turned.

As is well known, De Bary showed that if his interpretation of the facts was right, we have the principal groups of the fungi ascending along one main path of development. Starting with the *Phycomycetes*, which include the mucors and the fungi of the potato-disease and vine-disease (and which are so obviously allied to certain green algæ that it was impossible to doubt that these lower fungi are derived from green algæ), the main path of evolution was traced through the lower ascomycetes, such as the fungi of the hop-disease, and the higher members of the same series—*e.g.* ergot of rye, the larch-disease, &c., and found to end in the Uredineæ or "rusts," and basidiomycetes—the mushrooms, toadstools, and puff-balls, &c.

From this main series, branches were regarded as given out at various points, as the *Chytridiaceæ*, *Ustilagineæ*—the "smuts" and "bunts" of our cereals, &c.—and so on.

De Bary pointed out very clearly that the most astonishing morphological phenomenon observable in the fungi is the gradual loss of first functional sexuality, and then of even the last traces of sexual organs, as we ascend from the lower to the higher fungi.

Brefeld—and it should be stated that the book before us is almost entirely an admirable short edition of Brefeld's ten large volumes—maintains that De Bary and his pupils were wrong in interpreting the organs of the ascomycetes in question as sexual, and that the loss of sexuality among fungi occurs much sooner than was supposed. The sexual organs, in fact, disappear within the limits of the *Phycomycetes* themselves, and De Bary's ascocarp and pollinodium lose all the significance his hypothesis assigned to them.

But De Bary's chief mistake—into which he was led by the above interpretation of his own observations—was in deriving his ascomycetous series from *the wrong branch of the Phycomycetes*. Instead of their origin being from the Peronosporeæ (*Oomycetes*) the ascomycetes are derived from the *Zygomycetes*, their line of descent passing through a group containing *Protomyces* and *Thelebolus*, and which group Brefeld terms the Hemiasci.

The oomycetes, indeed, are regarded as leading nowhere, except to the richly branched genera which compose it.

While the ascomycetes represent an enormously branched and successful series of forms which have specialized the type of the *sporangium* more and more, the basidiomycetes (in which the author includes uredineæ) have come off from another group of zygomycetes, and have specialized the *conidium* as their type of reproductive organ. The half-way group along this line is the Ustilagineæ, and Brefeld terms them Hemibasidii, accordingly.

The grounds for these revolutionary views cannot of course be explained in a review. They depend upon the numerous new facts brought to light by the untiring devotion and industry displayed in the Münster laboratory, and which are very clearly described and illustrated in the book before us.

A number of new forms have been discovered, of which the simple *Ascoidea rubescens* is an interesting example.

Very instructive types, as yet unknown in text-books, are *Thelebolus*, *Pilacre*, *Tomentella*, *Tylostoma*, and some others; owing partly to the new facts brought out regarding them, and partly to the suggestiveness of the new views as to their morphology, such forms bid fair to become as well known in future hand-books as *Mucor*, *Podosphæra*, and *Agaricus*, are in those of to-day.

The generalizations regarding the comparative morphology of the reproductive organs of fungi as a whole are distinctly an advance, and show a delightful gleam of light leading to freedom from the chaos of terms the subject has laboured under: "pycnidia" and "spermogonia" disappear as such—they are merely chambers in which conidia are developed (*conidien-früchte*), the germination of numerous spermatia by Brefeld and others having established the conidial character of those mysterious particles, the spermatia.

The author's views regarding *Chlamydospores* will probably cause surprise to many who have not followed the progress of Brefeld's work during the last few years. If these views are accepted, the principal "spores" of *Protomyces*, the *Ustilagineæ*, and the *Uredineæ* are all to be interpreted as *Chlamydospores*, homologous with the resting spores of Mucor; even more startling is the discovery of such Chlamydospores (including "oidia" and "gemmæ") among the higher ascomycetes and basidiomycetes, novelties which are only equalled perhaps by the rich series of true conidial spores found in the latter group.

Zopf's work on fungi had already prepared us, in 1890, for some of the changes which these discoveries entail, but Zopf was not prepared for anything like the revolution which Von Tavel has accepted—and, indeed, so great a change of front was impossible before the publication of Brefeld's ninth and tenth volumes.

The new "comparative morphology of the fungi" certainly offers many advantages in the simplification of our views as to the nature of the spore, and promises to remove the bone of contention which this item has always offered to mycologists. We are asked now to accept the following view. There are four types of sporogenous organs in fungi:—(1) The *sexual spore*, only met with in the lower fungi (*Phycomycetes*), as the zygospore and the oospore, and gradually losing the sexual character within the group. (2) The *endospore*, formed asexually in a sporangium, and occurring as zoospores (Peronosporeæ, &c.), sporangiospores (*Mucor*, *Thelebolus*, &c.), or ascospores (all ascomycetes), the ascus being merely a sporangium of *definite* shape and size, and containing a *definite* number of endospores. (3) The *conidium*, which starts as a one-spored sporangium where *the sporangial wall and that of the contained spore fuse*, illustrated by the "yeasts" of Ustilagineæ and many ascomycetes, the "sporida" of Uredineæ, and the "conidia," "stylospores," "spermatia," &c., of Uredineæ and ascomycetes. The "*Basidium*" is merely a specialised conidiophore where *the position and number of the conidia* ("basidiospores") *are constant*, and true conidia occur in the group in addition—*e.g.* *Heterobasidion*, *Tomentella*, &c. Indeed, it is the play on this type leading to gradual specialisation which characterises the whole Basidiomycetous series. (4) The *Chlamydospore*, which, in the form of the type or of so-called "oidia," "gemmæ" occurs generally in all the series, and becomes specialised into "fructifications" in the *Uredineæ*.

This is perhaps a fair sketch of the central ideas of the new school, though it by no means summarizes or even mentions dozens of other interesting points brought out in the book under review, such as the remarkable evolutions of the germination—*e.g.* in *Nectria*—of the conidiophore—*e.g.* in *Peziza*—of the conidium, the basidium, the ascus, &c.

In conclusion, it may be pointed out that although Von

Tavel writes more fairly with regard to the work done by other schools, and has wisely avoided the bitter methods adopted by Brefeld towards De Bary's pupils in some of his volumes, there still seems to persist a tone of under-valuation of the work of the Strasburg school. After all, it should never be forgotten that unless De Bary and his pupils had followed up the clue—however false it may prove—of the "sexuality" of the ascomycetes, the matter would have had to be investigated, and the fact that the Münster school is enabled to explain the phenomena seen in a new sense proves how valuable De Bary's careful observations were. Moreover, however probable Brefeld's view of the origin of the ascomycetous series is—and it is now the clearest story yet put forward—many of his own facts show that the *impossibility* of De Bary's view of a sexual origin, now lost, of the ascocarp, is by no means proved. Brefeld insists that the simplest ascocarp (*e.g. Thelebolus*) may be derived by suppressing the stalk and withdrawing the sporangium of a form like *Mortierella* into the investing barren hyphæ at its base; but the *zygote* of *Mortierella* also has investing hyphæ, and it would not be going much further to suppose the sporangium of the germinated zygospore of such a form to be similarly withdrawn into the invested capsule. This "wild hypothesis" would not alter Brefeld's view as to the homology of the ascus, or the derivation of the ascomycetes from the zygomycetes, but it would, and very materially, alter the attitude adopted towards the sexual hypothesis. We have termed the suggestion "wild," but it is possibly not more so than Brefeld's own hypothesis as to the nature and evolution of the chlamydospore, and we imagine that the last word has not yet been said on either matter. However that may be, Brefeld's laurels of results are such as are won by very few investigators and Von Tavel is to be congratulated not only for his own discoveries, but also on his book, which is by far the best exposition of the subject in existence.

H. MARSHALL WARD.

DAUBRÉE ON THE GEOLOGICAL WORK OF HIGH-PRESSURE GAS.

A SERIES of experimental researches which promise to lead to important results, and which have already been applied by their author to the explanation of some difficult geological problems, have during the last few years been carried on by M. Daubrée. These experiments are concerned with the action of rapidly moving and high-pressure gas on rock masses, and lead to the conclusion that such high-pressure gas is a geological agent of no small importance. To carry out such experiments is no easy matter, but M. Daubrée has been fortunate enough to obtain the use of the apparatus used in the testing of explosives in the *Laboratoire Centrale des Poudres et Saltpêtres*. The high-pressure gas has been obtained by the explosion of gun-cotton and dynamite, the explosions being made in a steel cylinder with very thick walls, and closed at both ends with steel plugs. One of these plugs is fitted with a platinum wire, by the heating of which the charge can be exploded. The other, which under ordinary circumstances contains the manometer for measuring the force of an explosion, is modified so as to contain a block of the rock to be experimented on. A circular hole, moreover, is made at one end so that the gas, after traversing the rock, is allowed to escape. The rock, cut in the form of a cylinder, is supported between a steel stopper and the head of a piston. The charge of gun-cotton or dynamite usually filled a tenth part of the interior, and the pressures obtained were from 1100 to 1700 atmospheres. In one experiment the pressure was increased to 2300, and in another the still greater pressure of 2400 atmospheres was obtained. Many different kinds of rock were used, such as limestone, gypsum, slate, and granite, and each cylindrical block experimented on was cut through by a diametrical plane. In some of the experiments an additional very fine perforation was made along this plane.

As a result of the sudden shock of the explosions most of the rocks were fractured. In the case of the slate this resulted in faulting. The limestone and granite were broken up and crushed, but under the influence of the pressure the small fragments were quickly consolidated so as to resemble the original rock. This property of reconsolidating under pressure, thus shown to be possessed by rocks, seems analogous to the plasticity of ice observed by Tyndall.

All the rocks experimented upon, even the most tenacious, have undergone more or less erosion. The gases have disintegrated and pulverised them, and carried out the fragments. When their action was concentrated along certain lines, true perforations—that is to say, rounded channels more or less regular—were eroded through the blocks. In the case of a granite block the original perforation of 1·2 mm. was increased to a channel of 11 mm. The walls of these perforations after the explosions were found to be striated and polished. Sometimes the striations are parallel, like those produced by ice. At other times they spread in fan-form, and sometimes they are slightly curved.

The products of erosion are thrown out into the atmosphere, and an examination of the powder thus produced shows that a portion of the same possesses an interesting resemblance to the dust usually held to be of cosmic origin.

M. Daubrée applies the results of his experiments to explain the remarkable "diamond pipes" of South Africa. These diamond deposits are described by M. Mouelle in the *Annales des Mines* (tome vii. p. 193, 1885) as filling in cylindrical cavities of unknown depths in the rocks. These cavities appear to be cut out of the subjacent sedimentary or eruptive rocks, their upper parts are filled with a soft yellow decomposed rock matter, while below they contain hard volcanic conglomerate. They vary in size from a diameter of 20 to one of 450 m., and are originally surmounted by slight eminences, known as *kopyes* (little heads).

An interesting point about the general arrangement of the "pipes" is their occurrence along a straight line of 200 kilometres in length. Their walls, again, are smoothed and finely striated. These striations are often parallel, and indicate a powerful thrust from below upwards. No alteration is observable in the beds of shale forming the walls, except a slight elevation of their edges.

Thus in their general form, as long, narrow, cylindrical perforations in the earth's crust, they resemble the artificially produced perforations in the rocks experimented on. Their arrangement along a straight line suggests that they may have been opened along a line of fracture as were the perforations in the experiments. In the latter, the line of the eroded channel was determined by a very narrow perforation, and M. Daubrée suggests that in the former the positions of the "pipes" may have been determined in some cases by cross-fractures. The polishing and striation of the walls of the diamond pipes, again, is reproduced in the polishing and striation of the perforations in the experiments.

Another application of his experimental results made by M. Daubrée is to explain the opening out of the channels by which volcanic products reach the surface. Here, again, the linear arrangement of volcanoes, which has been so frequently pointed out, is noted as connecting volcanic vents with the experimental results. These are supposed to lie along lines of fracture, and each volcano is supposed to have been determined by a cross fracture, or some other cause, facilitating the passage of gas at that particular point. That there are reservoirs of gaseous pressure of great power below the surface is evident from volcanic phenomena generally, and given a line of fracture, with cross fractures, or other predisposing causes, the experiments prove that high pressure gas is capable of opening out cylindrical passages by which molten rock matter and fragments may reach the surface. In this connection, M. Daubrée points out the occurrence of volcanic craters, of which the cones are formed entirely of rock fragments, and known as "craters of explosion." Thus, near Confolens, in Velay, there is a crater excavated in the granite, and of which the cone is formed entirely of granitic fragments.

M. Daubrée further applies his experiments to explain, (1) the fracturing and crushing of rocks; (2) the transport of their debris; and (3) their apparent plasticity.

Some further results show that the high pressures of some of the earlier experiments are not essential, but that complete perforations can be obtained with pressures of 1100 atmospheres. A cylinder of granite, cut in two by a diametrical plane, and bound together with a ligature of copper, was thus excavated along its whole length by an irregular channel which opened on the surface by two branches. In the case of a cylinder of rock of which the height greatly exceeded the diameter the perforation tended to the form of two cones united by their summits. The action of the gases is not confined to the drilling of the perforations, they have likewise grooved and striated the surfaces of the divisional planes of the cylinders. These striations and groovings are not produced, as might be supposed, and as M. Daubrée himself at first believed, by solid particles of rock carried by the gas, and use as graving tools. It appears, in fact, that the gases themselves are able to striate and groove the rock on their first contact with it.

As an interesting corollary to his experiments, M. Daubrée points out, that leakage from steam pipes may in a similar way cut through metal plates. An example is quoted in which metal exposed to the escaping vapour from a steam pipe (pressure, seven atmospheres) was channelled and striated: the resulting marks were similar to those of a saw or file. A valve on a steam pipe, again, has been attacked in a similar way.

All these groovings in the metal have received a similar polish to that given by emery.

In the experiments the gases have in general caused the fusion of the surfaces which they have attacked. Thus, on the surfaces of the divisional plane of a granite cylinder the felspar is melted into white globules forming small projections. The plates of mica have also been softened. Even the quartz has not escaped, but appears pitted in a manner which recalls the erosion produced by hydrofluoric acid.

Scales of the rock are detached by the very unequal expansion as by a sort of shock.

A black crust exactly similar to the crust of meteorites has been produced with certain stones.

The transport of the debris produced in the perforation of the cylinders of rock is applied by M. Daubrée to the history of certain cosmic dusts, and the sediments existing in some of the deeper parts of the ocean. In making the perforations the gases carry out a quantity of debris. A part of this was collected on sheets of cardboard covered with vaseline. The particles arrange themselves in concentric circles on the sheet according to their size. Some of the large particles pierce the cardboard, and even its supporting plate; the very fine particles are carried to a distance by the gases, which they render opaque. In the powder retained on the cardboard, two sorts of grains can be distinguished under the microscope. The first are indistinguishable from those produced by simple mechanical pulverisation; the second have a special character intimately connected with the particular conditions of the experiment.

Thus, in the case of granite, fragments of all three constituents, quartz, felspar, and mica, are found in the powder produced. But besides this, minute, perfect or nearly perfect, spheres are found. These are opaque and black, or slightly translucent and brownish, with a glistening surface, and sometimes furnished with a very characteristic neck. They are doubtless the products of fusion.

This latter part of the powder of erosion seems identical with certain parts of the atmospheric dust, and that found in the deeper ocean, as well as in geological formations of various ages, and which have generally been looked upon as of extra-terrestrial origin. Thus the conclusion is arrived at that, while part of the so-called cosmic dust is undoubtedly of extra-terrestrial origin, the opening of volcanic and other channels in the earth's crust by high-pressure gas has also played an important part in its production.

Eruptive breccias may also have been produced by the force of high-pressure gas, as shown by the fracturing, breaking up, and reconsolidating of the rocks experimented upon.

A more remarkable fact is the passing back of the pounded and broken-up rock to its original solid state under the influence of the same gaseous pressure. Thus the fragments of the rock in the experiments were found to have moulded themselves so exactly on the containing steel apparatus as to have acquired a specular polish. The rock had, moreover, taken the impress of striations upon the steel. Limestone thus regenerated showed a schistosity concentric with the cylinder. It seems obvious, then, that the rocks of the earth's crust, having so frequently been subjected to enormous pressure, and so often folded and contorted, must in a similar way have been broken up and regenerated.

Another experiment showing the apparent plasticity of rocks is as follows:—

A cylinder of Carrara marble without a preliminary fissure, but with furrows on one of the ends and on the side, was placed in the apparatus and subjected to a pressure of 2400 atmospheres. It was afterwards found to be perforated with a channel, and moreover to be accurately moulded on the containing apparatus so as to take the impress of the concentric striations as in former experiments. The furrows were completely effaced, while the diameter of the cylinder was increased and its height diminished.

The ejection of rocky matter through the channels perforated by high-pressure gas occupies another paper. In such high-pressure gas M. Daubrée contends we have an agent capable of accounting for the facts in conformity with his experimental results. Special reference is made to certain trachytic domes—as, for example, those of the high plateau of Quito—of which the form seems to indicate that the rock matter forming them was ejected in an almost solid state. These domes, M. Daubrée supposes, crown the summits of orifices (diatremes) opened by the passage of high-pressure gas, and were themselves afterwards forced out by the same pressure. Attention is called to the remarkable uniformity in height observable in groups of volcanoes. This is explained as the result of origin from one common reservoir of pressure. The height of the volcanic cone gives a measure of this pressure. On the other hand, the hypothesis likewise explains the difference in height in different regions. Thus, in certain cases, reduction of pressure would be effected by lateral escape of gas, as happened in certain experiments in spite of the utmost care. A similar reduction of pressure may have occurred through the blocking of the channels of egress of the gas. This, too, occurred in certain of the experiments, notably when gypsum was the rock experimented on. With this rock the channel opened by the gas was quickly closed again by the rapidity with which the triturated rock resolidified. The paper concludes with a suggested application of the hypothesis to the cones and craters of the moon.

In another paper M. Daubrée returns to the subject of the flow of rocks under high pressure. With respect to this point he remarks that, in certain previous experiments, the rock not only accurately moulded itself to the apparatus, but also formed thimble-shaped protuberances outside it. Further experiments were conducted with round plates placed one upon another, instead of the former cylinders. Lead plates were first experimented on, and then these along with plates of rock. One of the most interesting results obtained was the production of little "eruptive cones" of lead or rock outside the apparatus. In one case the protuberance reached the height of 36 mm. After the experiments, some of the plates were found outside the apparatus in the form of circular capsules, so closely fitted into one another as to appear soldered. Some of the lead plates remaining in the apparatus were cut through in their central parts as with a punch. The thickness of these perforated plates was found to be diminished on their borders, and increased in their central portions. This effect may be compared to what occurs in many cases with contorted rocks. At the same time spaces were here and there formed between the plates thus united. Daubrée draws attention to the analogy between these spaces and those occurring between separate strata among contorted rocks, and which are often filled with metallic substances. Lamination was also produced in the plates of rock.

As a general designation for the accumulations of rocky matter crowning the summits of all perforations in the earth's crust opened by gaseous pressure, whether trachytic domes, lava flows, scoriæ cones, or the kopyes of South Africa, M Daubrée proposes the term "ecphysema" (French, *ecphysème*," Gr., ἐκφύσημα).

To sum up M. Daubrée's results:—

(1) High pressure gases from below are able to open out channels in the earth's crust, by means of which the same pressure can bring to the surface various products.

(2) In forming such channels the gases may striate and polish the walls of the perforations in a manner recalling that of glacial action.

(3) The products of such erosions are partly of the nature of fine dust, which may be carried to immense distances, and a part of which resembles exactly the so-called cosmic dust.

(4) That the same high-pressure gas can fracture, break up, and pound a rock, and afterwards resolidify the same. That in thus resolidifying, the broken-up rock may mould itself accurately on the bounding walls of its enclosure, so as to take their polish and the impress of the striations upon them And, further, that portions may be thrust outside the apparatus in the form of protuberances of the nature of "eruptive cones." And thus it may be conceived that, by the force of high-pressure gas from below, rocks may be broken up and reconsolidated *in situ* to form breccias of diverse natures.

Some further applications of the experiments may be suggested.

Thus they may perhaps explain the origin of those remarkable natural pits of Hainaut, which have given rise to much discussion. In their general structure these pits are analogous to the diamond pipes of South Africa. Like them they are more or less circular perforations in the rocks, of unknown depth, and filled with rock debris. Since none of the explanations hitherto applied to them seem satisfactory, perforation by high pressure gas may be tried.

Again, in certain of the experiments the faces of the fissures in the cylinders of rock were found to be polished and striated. The polishing and striation of rock surfaces in connection with faults is known as slickensides, and ascribed to the movement of one surface over the other. M. Daubrée's results indicate the possibility that certain slickensided surfaces may rather be due to the energetic action of high pressure gas. In any case it is perhaps a little difficult to understand how a *single* movement of one rock surface over another—if we suppose a fault produced by a continued movement in one direction—could produce anything like a perfect polish. And it cannot be denied that the above experimental result shows the possibility of another cause.

And further, if we accept M. Daubrée's interpretation of his results, we arrive at the remarkable conclusion that gaseous bodies, given sufficiently high pressure and rapid motion, can polish and striate in a way generally supposed to be confined to solid bodies. This, indeed, is in conformity with the general results of advanced physical research which tends to show that, under sufficient pressure, hard and solid bodies can be made to act as liquids, while soft and even gaseous bodies, if endowed with sufficient force and speed, act like solids.

If, then, a gaseous body, under certain conditions of speed and pressure, can polish and striate a rock without the intervention of solid particles, is it not possible that ice, given certain conditions of speed and pressure, may likewise striate and polish without the graving tools usually considered necessary? The conception of an ice-sheet, or glacier, moving over the rock surface of the country with a series of pebbles and boulders firmly frozen into its lower surface is difficult to reconcile with the physics of ice masses in motion. Hence it seems worth while to make a trial application of the experimental results in this direction likewise. Even if we do not accept M. Daubrée's view that the striation of the rock surface was accomplished by the gas alone, and hold that the intervention of solid particles was required, there is still a possible application to glacial action. For if solid particles simply carried along by a rapidly-moving gas can produce parallel striations, may not particles simply carried along by the ice do likewise without being held firmly frozen into its mass? On either view, in fact, a difficulty in the conception of how a glacier striates and polishes is removed.

NOTES.

THE professors of the University of Melbourne have interviewed the Premier on the subject of the decrease in the grant to that institution. They said that there was no possibility of reducing the present staff, as it was not overmanned. Many of their number had come to the colony under special contract with the authorities of the university, and it would be a serious matter if faith were broken with them by insisting on a reduction in their salaries. Mr. Patterson replied that these were times of retrenchment, and it was right that everybody should contribute something to pull the country out of its difficulty. It appeared, however, that the University had been cut down £5000 last year, and it was further proposed to reduce the expenditure on the institution by £3000. He reiterated generally the statement made by the Minister of Education on the subject of retrenchment, but he promised to hold a consultation with Mr. Campbell, with the view of ascertaining if anything could be done in the matter. He thought it possible that Mr. Campbell, on taking a review of the special circumstances of their case, might see his way to some abatement of the rigorous course which had been proposed.

A MEETING of the Executive Committee of the Rothamsted Jubilee Fund was held on Monday, the Earl of Clarendon in the chair. On the motion of the Chairman, the Duke of Devonshire, as the incoming President of the Royal Agricultural Society of England, was added to the Committee. Sir John

Evans (hon. treasurer) reported that the fund now amounted to £572 13*s*., that the granite memorial proposed to be set up in front of the Laboratory at Rothamsted was nearly ready, and that the portrait of Sir John Lawes, by Mr. Hubert Herkomer, was in progress. It was decided to request the Minister for Agriculture to preside at the dedication of the memorial and the presentation of addresses to Sir John Lawes and Dr. Gilbert by various learned societies, on Saturday, the 29th inst., at 3 p.m. It was also decided that the fund should not be closed until after the presentation, and subscriptions (not exceeding two guineas) will be received until further notice by Mr. Ernest Clarke, hon. secretary, at 12, Hanover Square.

THE next meeting of the Australasian Association for the Advancement of Science will commence in Adelaide, South Australia, on September 25, 1893, under the presidency of Prof. Ralph Tate, of the University of Adelaide. The Association has been in existence since 1888, and now numbers over 900 members. The four previous meetings, held at Sydney, Melbourne, Christchurch, and Hobart, under the presidencies respectively of Mr. Russell, Baron von Mueller, Sir James Hector, and Sir Robert Hamilton, K.C.B., have been very successful. It is hoped that some visitors from the old country may be induced to attend the coming meeting, where they may count upon a cordial welcome. The time fixed is eminently suitable for visitors; and in previous years the Colonial Governments and the local steamship companies have granted substantial reductions of fares to members of the Association, and it is anticipated that the same privileges will be continued on the present occasion. We may add that at the request of the local secretaries, two former members of the Adelaide University, Prof. T. Hudson Beare, of University College, London, and Prof. Horace Lamb, of the Owens College, Manchester, have underaken to answer inquiries, and to give all information in their power to intending visitors.

DR. ARCHIBALD SANDEMANN, who at one time was Professor of Mathematics at Owens College, Manchester, died at Perth a few days ago. He was seventy-one years of age.

AT a special general meeting of the Geological Society, on June 21, it was decided to have an index prepared to the first fifty volumes of the Quarterly Journal, at an expenditure not exceeding £450. If possible, the index will be issued early in 1895, in two numbers in paper covers, uniform with the Quarterly Journal, and as a supplement to volume fifty.

AT the first meeting of the recently elected Council of the Institution of Civil Engineers the following reappointments were made:—Mr. Hugh Lindsay Antrobus as Treasurer, Dr. William Pole, F.R.S., as Honorary Secretary, and Mr. James Forrest as the Secretary. The Council consists of Mr. Giles, President; Sir Robert Rawlinson, K.C.B., Sir B. Baker, K.C.M.G., F.R.S., Sir Jas. N. Douglass, F.R.S., and Mr. J. Wolfe Barry, Vice-Presidents; Dr. William Anderson, F.R.S., Mr. Alex. R. Binnie, Sir Douglas Fox, Sir Charles Hartley, K.C.M.G., Mr. J. C. Hawkshaw, Mr. Charles Hawksley, Prof. Alex. B. W. Kennedy, F.R.S., Sir Bradford Leslie, K.C.I.E., Mr. James Mansergh, Sir Guilford L. Molesworth, K.C.I.E., Mr. W. H. Preece, F.R.S., Sir Edward James Reed, K.C.B., F.R.S., M.P., Mr. William Shelford, Mr. F. W. Webb, and Mr. W. H. White, C.B., F.R.S.

A MEETING of the Yorkshire Naturalists' Union will be held at Kirkwood, Moorside, on Monday, July 10, for the investigation of the neighbourhood of Donthwaite Dale, Sleightholme Dale, and Kirkdale.

THE curator of the Maidstone Museum has printed and is circulating an Exchange List of duplicate lepidopterous insects contained in the museum. It embraces the Rhopalocera only, and upwards of 5000 specimens are available for distribution. Copies of the Exchange List can be had on application. The housing and proper supervision of duplicate natural history specimens has become in many museums a serious tax upon the ingenuity and time of the curators, and it would seem very desirable that exchange lists should become more general than is the case at present. Their value would be greatly increased, moreover, if for this purpose a uniform system of nomenclature were adopted.

TWO prizes of $150 and $75 respectively will be awarded by the Anthropological Society of Washington at the end of this year for the best essays on the elements that go to make up the most useful citizen of the United States, regardless of occupation. The prizes are open to competitors of all nationalities. While it is not proposed by the Society to limit the scope of the discussion, and while each essay will be considered on its merits by the Commissioners of Award, it is suggested, in view of the character of the Society and the wishes of the donor of the prize fund, that the treatment be scientific, and that the potential citizen be considered (1) from the point of view of anthropology in general, including heredity, anthropometry, viability, physiological psychology, &c.; (2) from the point of view of personal characteristics and habits, such as care of the body, mental traits, manual skill, sense training and specialisation, and all-round manhood; and (3) from the ethical point of view, including self-control, humanity, domesticity, charity, prudence, energy, *esprit de corps*, patriotism, &c. Essays submitted in competition for the prizes should be delivered not later than November 1, 1893, to the Secretary of the Board of Managers of the Society, Mr. Weston Flint, No. 1101 K Street, N.W., Washington, D.C., to whom all correspondence relating to the prizes should be addressed.

WE are requested by the Imperial and Royal Austro-Hungarian Consulate-General to call attention to the charitable foundation instituted by the Sisters Froehlich at Vienna, for making pecuniary grants to persons who have distinguished themselves in art, science, or literature. The grants are made irrespective of nationality, provided that the applicants are resident in Austria. Further information can be obtained at the Imperial and Royal Austro-Hungarian Embassy, 18 Belgrave Square, S.W.

A CORRESPONDENT, writing to the *Pioneer Mail*, says that Murree was visited by a terrific hailstorm on May 28. The hailstones are described as being fully the size of racket balls, and they bounded from the ground to a height of four or five feet. They did a large amount of damage to trees and flowers, and strewed the neighbourhood with small branches and leaves. Numerous panes of glass were broken, and the ground was covered with hail to a depth of between two and three inches.

IN the *Repertorium für Meteorologie* (vol. xvi.) A. Schoenrock describes a remarkable oscillation of temperature at St. Petersburg and neighbourhood on February 11 last. On the 10th the thermometer rose all day, the readings being $-12^{\circ}\cdot1$ F. at 7 a.m., $-0^{\circ}\cdot4$ at 1 p.m., $23^{\circ}\cdot4$ at 9 p.m., and at about 3.45 a.m. of the 11th, $28^{\circ}\cdot4$. At this time the thermometer began to fall very rapidly, the decrease being no less than 23° in the course of a quarter of an hour, and by 7 a.m. it had fallen to $2^{\circ}\cdot6$. The wind, which had been southerly on the morning of the 10th, suddenly changed to east-north-east on the morning of the 11th, the force being light on both days. The phenomenon was to a less extent observed at other stations around St. Petersburg; to the eastward it did not reach beyond Ssermaxa, but the westerly limit could not be determined for want of stations.

A USEFUL discussion of the normal distribution of the rainfall in the Madras Presidency, based on the records of twenty years (1870-89), has been published by C. Benson, Deputy Director of the Department of Land Records and Agriculture. The year has been divided into four periods :—(1) the hot weather, April and May ; (2) the south-west monsoon, June to September ; (3) the north-east monsoon, October to December ; and (4) the dry weather, January to March. And the Presidency has been divided into sixty-four tracts, or groups of stations, lying in physico-geographical areas which showed, on inspection of the records, the greatest similarities. The results of the annual distribution of rainfall, from which we take a few extracts, shows that this selection of areas is correct in principle, and that any general average for the whole Presidency would be, as the author states, misleading in the extreme. Over the greater part of the Presidency the heaviest rainfall is brought by the south-west monsoon ; the north-east monsoon only brings any considerable amount along the Coromandel coast. Over the whole of south Canara and in the northern part of the Wynaad the annual fall exceeds 125 inches, and in a portion of the former it amounts to nearly 180 inches. On the coast of Malabar it amounts to from 108 to 117 inches, while further inland, in the same district, it is only about 75 inches. Besides the above localities, it is only on the western slopes of the Nilgiris, where the annual fall amounts to rather over 90 inches, that it anywhere exceeds 70 inches. In a few other localities the rainfall exceeds 50 inches, while it is only over a comparatively small portion of the Presidency that the annual fall amounts to 40 inches, and over a very large section of it it does not reach 30 inches. The dryest section of the Presidency lies in the Bellary and Anantapur districts to the north of Mysore, where the average rainfall does not reach 21 inches.

THERE is perhaps no micro-organism which has been so exhaustively studied as regards its behaviour in water as the *Bacillus anthracis*. The list of memoirs on this subject has moreover been lately increased by the elaborate report just issued to the Water Research Committee of the Royal Society, entitled, "The Vitality and Virulence of *B. anthracis* in Potable Waters," by Percy Frankland and M. Ward. Additional interest and importance must however now be attached to these researches, inasmuch as quite recently this organism has been actually discovered in the mud at the bottom of a well ("Bactéries charbonneuses dans la vase du fond d'un puits," by Diatroptoff, *Annales de l'Institut Pasteur*, March, 1893). An epidemic of splenic fever broke out amongst some sheep on a farm in the South of Russia. Thinking that the disease might be connected with the use of a particular well water, the latter was bacteriologically examined. Diatroptoff was unable to discover the anthrax bacillus in the water, but an investigation of the *mud* at the bottom of the suspected well revealed the presence of an organism, which on inoculation into animals was proved beyond doubt to be the *B. anthracis*. On the well being closed no further cases of anthrax occurred. That the germs of anthrax had in some manner gained access to the well is certain, and opens up the possibility of the communication of this disease by means of drinking water. Moreover the likelihood of such contamination taking place through the drainage from soil, points to the desirability of destroying the carcases of infected animals by cremation rather than by burial.

ACCORDING to Faraday's electrolytic law we ought to obtain the same amount of metal deposited on the anode, for a given current, whatever the composition of the electrodes. However, Dr. Oettel (*Chemiker Zeitung*) finds that with platinum electrodes the deposit of copper is only from 74 to 89 per cent. of that obtained with copper electrodes, the density of the current being 0·13 ampères per square decimetre, and no free hydrogen being liberated. The cause of this divergence is the formation at the anode of persulphuric acid and of hydrogen dioxide, which diffuse in the liquid, and reaching the cathode become reduced, causing a diminution in the quantity of metal deposited. The addition of an easily oxydised body, such as formic acid, annuls the action of these secondary products, and increases the quantity of copper deposited to 98·7–99·6 per cent. of the theoretical quantity. Alcohol is still more efficacious, 99·9 per cent. being obtained.

DR. OETTEL has also investigated the divergences observed in the weight of the deposit in the copper voltameter when an acid solution is employed. The divergences are of such a magnitude that it has been generally recommended to use a perfectly neutral solution, although the resistance is in this case much higher. The author, however, finds that, with a current density less than 0·3 ampères per square decimetre, the neutral solution gives too heavy a deposit. When an acid solution to which alcohol has been added is used, the results agree with those obtained with the silver voltameter. The best results are obtained with a solution consisting of 15 grms. of copper sulphate, 5 grms. of sulphuric acid, and 5 grms. of alcohol mixed with 100 grms. of water, the current density being between 0·06 and 1·5 ampères per square decimetre.

A LETTER from Sir David Salomons appears in the *Electrician* in which he says that when trying some of the experiments shown at the Royal Society *soirée* by Mr. Pike and himself he found that the attraction between two vacuum tubes far exceeded what theory would expect, if due only to static effects, or to the mutual action of one current upon another. Further experiments (though not yet completed) have shown that :—(1) Two vacuum tubes attract one another strongly. (2) The attraction is almost, if not quite, the same, whether they touch one another along the whole length or only at their ends, one of the tubes being dumb-bell shaped. (3) A spiral vacuum tube sucks in a "core" tube like a solenoid does an iron core, and the more the "core" is drawn in the less luminous the "core" tube appears. The core tube in this experiment was not connected to the circuit. (4) When the tubes are placed end on they attract one another and stick together ; no repulsion takes place, which would occur if the effect were of a static nature.

MM. SORET AND GUYE have made an investigation to determine the rotatory power of quartz at low temperatures (*Archives des Sciences Physiques et Naturelles*, Geneva, March 15). During the observations, the specimen of quartz was immersed in alcohol, and the temperature of the liquid was determined by noticing the variation in the resistance of a platinum wire, the readings being compared with those given by an air thermometer. The instruments of research were arranged along an optical bench and the order was first a light source, then one of Cornu's polarising prisms. After the collimator came the bath containing the quartz. A Foucault's analyser followed, and last of all was a direct vision spectroscope minus the collimator. The source of light was a vertical sparking-tube having platinum electrodes arranged at the surface of a solution of bromide of sodium. From the experiments it appears that Joubert's formula (*Jour. de Phys.* 1879, viii. 1) represents approximately the rotatory power of quartz for sodium light down to a temperature of about − 70°.

CONSIDERABLE importance can at present be attached to a study of the properties of solutions of salts in different solvents, for such solutions appear to be the most likely to afford evidence as to the validity of the hypothesis of electrolytic dissociation. From measurements on the magnetic rotatory polarisation of solutions of salts in water, alcohol, pyridine, amyl alcohol, and acetone, Herr Schönrock (*Zeitschrift für physikalische Chemie*, xi. 6, 753) concludes that the specific rotation of a salt is independent of the concentration, and of the nature of the solvent, and that there is therefore no evidence of effects which might be attributed to electrolytic dissociation. Dr. Perkin pointed out in 1889 that the molecular rotation of chlorhydric acid calculated from the behaviour of a solution in water was twice as great as the value deduced from a solution in amyl oxide. This result has been employed by the upholders of the "new" theory of solutions as clearly indicating the effect of electrolytic dissociation. Herr Schönrock finds, however, that chlorhydric acid reacts chemically with amyl oxide, and that if allowance be made for this reaction, chlorhydric acid exerts the same effect on polarised light when dissolved in amyl oxide as when dissolved in water. In the same communication values are given for the specific and molecular rotations of some fatty and aromatic hydrocarbons, fatty alcohols, &c., and relations are established between the magnitudes of these constants which are similar to those discovered by Dr. Perkin. The rotations of solutions of double salts are also treated in the paper.

AT a recent meeting of the Berlin Society of Naturalists, Herr Ascherson spoke on the metallic-looking deposit often found on the teeth of ruminating animals in Southern Europe and the East. Hertwig described a silver-like crust on the back teeth of a goat in Xante, as composed of fine lamellæ, and of calcium-carbonate with some iron. In most cases, however, the coating is rather of a gold, bronze, or brass colour, and the yellow pigment is probably of organic origin. It is more common to meet with the deposit on the molars of wild ruminants (especially antelopes) than on those of domesticated animals. Natives of the Mediterranean region say the gold colour is due to eating a mysterious, light-giving plant, very difficult to find, but much desired, as it changes all that it touches to gold, or indicates gold in the ground, or can be used for gold-making. Various plants have been specified as the source of the deposit, one being the Lebanon poppy, the ground leaves of which have a remarkable golden look, very similar to that of goats' teeth, so that a causal relation between the two has seemed natural. Dried remains of the plant, too, have a bright metallic lustre. An examination by Herr Graebner shows the gold colour to have its seat in the moderately thickened cell membranes of the tissues concerned; but the shining look apparently comes from a thick deposit of wax on the epidermis. The teeth of certain fossil ruminants have been found with similar incrustations, *e.g.* molars of Samotherium from the miocene of Mitylene in Samos.

AT the bottom of the valley of St. Martin, near Millau (Aveyron), the Boundoulaou grotto pierces the calcareous rocks of a promontory of the Larzac. There are four entrances on the face of the cliff; the most practicable lies on the western flank at a height of 535 m., and may be reached with the help of a ladder 14 m. long. It was explored last autumn by M. E. A. Martel, who, in conjunction with M. Émile Rivière, describes his finds in the *Comptes Rendus*. It was found to consist of three galleries, one above the other, the lowest of which contained a lake which fed two perennial springs emerging at a point lower down. This lake was explored with great difficulty in a canvas boat under a vault hardly 1 m. high. In the middle of the cave was found a kind of dome 25 m. high and wide, evidently hollowed out by water. In the upper gallery, 15 m. above the level of the lake, the explorers encountered a neolithic bone deposit containing a large fragment of pottery, a well-made cylinder of bone, and seven human skeletons. Three of these were arranged side by side under a sort of shed of rocks, with their heads touching each other. It seemed as if these persons had been surprised and drowned by a sudden flood of the lake below. One of the skulls is that of a young male adult remarkable for the thickness of the cranial bones and for the want of complexity in the sutures. The second complete skull belongs to a subject not completely grown up, and probably of the female sex. Besides these skulls many other human remains were found, including six mandibles, seven humeri and one cubitus, three femurs and five tibias, and one left ilium, amounting in all to traces of seven skeletons. Speaking generally, the type resembles that of the Caverne de l'Homme Mort (Aveyron). An interesting relic also found was a bone cylinder made of the diaphysis of a human femur, and probably representing an amulet or a trophy of war.

A BIOLOGICAL station has been recently started on Heligoland. According to the recent report of the director, Herr Heinke, it contains, with other rooms, six workrooms with excellent light, one for the director, two for the assistants, a fourth for Dr. Kuckuck (who is engaged on the marine flora of the island), while the two others are for "ambulant" naturalists. The conditions of occupation of these will soon be published. The cellar space is being arranged for aquaria. Several boats with dredging and fishing apparatus are at the disposal of the inmates. One of these is a launch with petroleum motor; it has a small cabin, with cooking-stove, &c., so that the whole day can be spent comfortably on the sea. In the summer months arrangements will be made for excursions of several days. A few months' researches on the fauna and flora round Heligoland have revealed a greater richness in these than had been supposed. New forms, not before observed in the German North Sea, have come to light almost daily. The ichthyologist finds Heligoland a rich field; and interesting studies can be prosecuted on the larval forms of crustacea, on mimicry and protective colours in marine animals, and their relations to marine plants, &c.

MR. THOMAS E. BEAN contributes to the *Entomologist* for July the results of a fairly extensive breeding of *Colias christina* and *C. elis*, undertaken with a view of determining whether more male or female butterflies are produced. From seventeen separate broods of *C. christina*, 116 males and 143 females were raised, and nine broods of *C. elis* gave 32 males and 69 females. All the families were subjected to uniform treatment and condition, hence the results show that some cause or causes control the development of sex entirely apart from the influence of variations in nutrition. The sex proportions do not seem to be determined by the seasonal stage at which the eggs are laid, and Mr. Bean thinks that in some cases at least sex is dependent upon antecedent causes, the influence of external conditions not applying.

A NUMBER of special articles contributed to the *Hampshire Observer*, by the Rev. R. H. Clutterbuck, on the Whites of Selborne, Fyfield, and Abbots Ann, will shortly be published at the office of the journal, Winchester.

MESSRS. DULAU AND CO. have just issued parts xxiii. to xxvii. of their catalogue of zoological and palæontological works. They include works on general Entomology, Coleoptera, Diptera, Hemiptera, and Hymenoptera.

MR. JAMES BRITTEN and Prof. G. S. Boulger have reprinted from the *Journal of Botany* their "Biographical Index of British and Irish Botanists." It is largely rewritten, and completed down to the end of 1892, giving the names and other information respecting all British (and Irish *sic*) botanists known to the editors who had died before that time. It contains 1825 names.

THE Ealing Microscopical and Natural History Society has issued its sixteenth annual report. In it are given abstracts of lectures delivered at meetings of the Society during 1892, and some notes on the local forms of *Helix memoralis* and *hortensis*, prepared by Mr. A. Belt. There are few societies in the environs of London that are able to publish such satisfactory reports of their proceedings.

IT is only in a very narrow and restricted sense that statistical information gained by the ordinary census can be accepted as an indication of the educational status of a country. However, an attempt was made to obtain some figures under this head during the census of the colony of Tasmania in 1891. The standards taken was the ability to read and write, to read only, and to be able to do neither. The tabulation of the results of the inquisition shows that the percentage of persons who said they could read and write reached a maximum of 95·04 between the ages of fifteen and twenty, and then decreased gradually to 55·68 for persons of eighty-five years of age and over. Of all the persons whose respective ages were not less than fourteen, 88·77 per cent. could read and write, 3·50 per cent. could read, and 7·73 per cent. avowedly lacked the qualifications for either of those classes.

MR. S. COTTERELL has compiled a little handbook to various publications, documents, and charts connected with the rise and development of the railway system of Great Britain and Ireland. The book is published by Mr. Edward Baker, John Bright Street, Birmingham. It is a compact little bibliography of railway matters, and deserves to be issued in a much better form than it is at present.

TWO papers are contributed to the current journals upon the hitherto unisolated tetrachloride of lead. The earlier of the two, by Prof. Classen and Herr Zahorsky of the Aachen laboratory, is communicated to the *Zeitschrift für Anorganische Chemie*. During the course of an interesting series of experiments with liquid chlorine, it was observed that the liquid was entirely without action upon pure lead dichloride, $PbCl_2$, but that in presence of concentrated hydrochloric acid a solution of tetrachloride of lead was produced. Twenty-five grams of lead chloride were placed in two hundred cubic centimetres of fuming hydrochloric acid, and the mixture cooled by means of ice and salt. Liquid chlorine was then added and the vessel closed. After two days the lead dichloride had all disappeared and a homogeneous yellow liquid remained, consisting of a solution of lead tetrachloride in hydrochloric acid. All attempts to isolate the tetrachloride were unavailing, but upon adding ammonium chloride a double salt of the composition $2PbCl_4.5NH_4Cl$ crystallised out. This salt, containing tetrachloride of lead, forms yellow crystals which are quite permanent in closed vessels and withstand a temperature of 100° without change. The crystals are decomposed by water. If only a small quantity of water is added the dichloride separates and a solution of hypochlorous acid is formed. If much water is added a clear brown solution is produced which probably contains plumbic acid, $Pb(OH)_4$; this solution rapidly decomposes with separation of lead dioxide, PbO_2.

THE second paper, by Prof. Friedrich, of Graz, is contributed to the *Berichte*. Prof. Friedrich has succeeded in isolating the pure tetrachloride itself, $PbCl_4$. A solution in hydrochloric acid was first obtained by the action of chlorine gas on lead dichloride suspended in hydrochloric acid. From this the double salt with ammonium chloride was prepared by the addition of sal-ammonia to the liquid product. According to Prof. Friedrich, the composition of this salt is represented by the formula $PbCl_4.2NH_4Cl$. It was obtained in well-defined combinations of the octahedron and cube, and would appear to be isomorphous with the corresponding tin salt, $(NH_4)_2SnCl_6$, the well-known *pink salt* which was formerly so largely used as a mordant for madder dyes. When this double salt containing tetrachloride of lead is placed in strongly cooled oil of vitriol a somewhat energetic reaction occurs, the chloride of ammonium being decomposed with evolution of hydrochloric acid gas. But, strange to say, the tetrachloride of lead is not attacked by concentrated sulphuric acid, and it separates in yellow drops, which finally coalesce to form a heavy yellow liquid, which sinks to the bottom of the vessel. This may be purified by repeated agitation with oil of vitriol, and is eventually obtained after separation as a clear, yellow, very highly refractive, heavy but mobile liquid, which yields numbers upon analysis agreeing with the formula $PbCl_4$, fumes in contact with moist air, and decomposes slowly with separation of lead dichloride and escape of chlorine gas. Upon warming it suddenly decomposes with explosion, the dichloride of lead being produced in the form of a cloud tinted somewhat yellow by the free chlorine. Its specific gravity at 0° is 3·18. At − 15° it solidifies to a mass of yellow crystals. With a little cold water it forms a hydrate, probably $Pb(OH)_4$, which readily decomposes, and with excess of water it yields a precipitate of peroxide of lead PbO_2. When added to a little very cold concentrated hydrochloric acid a crystalline compound, probably of the composition $PbCl_4.2HCl$, is formed. When mixed with oil of vitriol and warmed in a current of hydrochloric acid gas the liquid may be partially distilled. As soon, however, as temperature reaches about 105° explosion occurs, as described above. In this respect, also, lead tetrachloride resembles tetrachloride of tin, which may be distilled without decomposition from a mixture with sulphuric acid.

NOTES from the Marine Biological Station, Plymouth.—Recent captures include large swarms of Salps, the nurses and young chains of *Thalia democratica-mucronata*. From the 15th to the 25th they were very common and in good condition; after the 25th they became reduced in number, and were much injured by the storm which occurred last week. In addition to the above there were observed numbers of *Obelia* and *Thaumantias* medusæ; and from time to time Echinoderm, Annelid, and Müller's larvæ, as well as *Cyphonautes* and the *Eudoxia* larva of *Muggiæa*. The Mollusc *Nassa incrassata* is now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. W. Henegan; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. J. H. Brown; three Common Marmosets (*Hapale jacchus*) from Brazil, presented by Mr. Hope Gibson; a Brown Bear (*Ursus arctos*, ♀) European, presented by Mr. F. Collier, F.Z.S.; two Wild Swine (*Sus scrofa*, ♂ ♀) from North Africa, presented by Mr. Jasper A. Mathews; a Purple Heron (*Ardea purpurea*) British, presented by Mr. R. Heywood; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mrs. Anna Margaret Hills; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, W.I., two Tree Boas (*Corallus hortulanus*) from Grenada, W.I., presented by the Hon. Sir Walter Hely-Hutchinson, K.C.M.G.; a Brazilian Cariama (*Cariama cristata*), a Barn Owl (*Strix flammea*), a King Vulture (*Gypagus papa*), a —— Buzzard (*Buteo* sp. inc.) from Brazil, presented by Mr. Howard C. Wolfe; an Illiger's Macaw (*Ara maracana*), two yellow-headed Conures (*Conurus jendaya*) from Brazil, two Rufescent Teguexins (*Tupinambis rufescens*) from Mendoza, deposited; six European Beavers (*Castor* ——) from the river Rhone, France, eight Garganey Teal (*Querquedula circia*), six Common Teal (*Querquedula crecea*) European, purchased; a Thar (*Capra jemlaica*, ♂), two Black-headed Gulls (*Larus ridibundus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET FINLAY (1886 VII.).—M. Schulhof, in the current number of the *Astr. Nach.* (3171) gives the new elements and ephemeris of Comet Finlay. They are as follows :—

$$\left.\begin{array}{rcl} M & = & 6^{\circ}\ 58'\ 5''\cdot33 \\ \pi & = & 7\ 41\ 34\cdot1 \\ \Omega & = & 52\ 27\ 42\cdot7 \\ i & = & 3\ \ 2\ \ 2\cdot1 \end{array}\right\} 1893\cdot0$$

$$\begin{array}{rcl} \phi & = & 46\ \ 0\ 49\cdot4 \\ \mu & = & 535''\cdot8046 \\ \log.\ a & = & 0\cdot5473335 \end{array}$$

12h. M.T. Paris.

1893	R.A. app.	Decl. app.
	h. m. s.	° ' "
July 6	3 26 58·9	+16 49 2·9
7	31 39·4	17 8 33·7
8	36 19·1	17 27 33·1
9	40 57·9	17 46 1·0
10	45 35·9	18 3 57·1
11	50 12·9	18 21 21·3
12	54 48·9	18 38 13·1
13	3 59 23·8	18 54 32·8

A BRIGHT COMET?—In a note under this heading which appeared in these columns on June 22, we gave an interpretation of a telegram from Kiel to one of the German Observatories. The message ran : "From Boston probably bright comet photograph, Lewis, 5 June, 09571 ; Boston 26423, 07558, 43552 ; 12 June, 10043 ; Boston 27119, 06904, 44066. Verbatim ventilate unpliable."

Unfortunately, after having translated the code on a separate sheet of paper, we set down the Boston times as the right ascensions, an error often liable to occur when one is used to reading right ascensions in hours, minutes, and seconds, and not in degrees of arc.

This telegram was distributed only to a few observatories in order to substantiate the discovery, or otherwise, before the announcement was openly made, and it was in the endeavour to present our readers with this piece of news as early as possible that this clerical error was made.

STARS WITH REMARKABLE SPECTRA.—In *Astronomische Nachrichten*, No. 3171, Mr. T. E. Espin continues his list of stars with remarkable spectra (*Astr. Nach.* 3090), the number amounting now to 736. The places are all brought up approximately to 1900.

THE PERIOD OF ROTATION OF VENUS.—It was hoped that the pure telescopic observations of the surface of Venus would settle the question of the period of rotation, but the results show that we are not yet in possession of the absolute value as can be gathered from a comparison of Schiaparelli's work with Trouvelot's, and Löschardt's and Wislicenus determinations. A method, apparently not yet tried, is that suggested by Egon von Oppolzer (*Astr. Nach.* 3170), which involves the use of the spectroscope for the determination of the motion in the line of sight. By comparing the spectra of opposite points on the equator, he says it might probably be possible to determine the time of rotation. Cassini de Vico's assumption involves a velocity for an equatorial point of somewhere about 473 metres per second, so that we should expect to get a motion, indicated in the spectrum by the displacement of the lines, of about 946 metres, or roughly, one kilometre. This motion, he thinks, can with our present means of measuring be made apparent, and we should thus decide between Cassini de Vico's assumption and Schiaparelli's 225-day period.

THE NEWALL TELESCOPE.—The report of the work done with the Newall refractor (*Camb. Univ. Reporter*, June 20) shows that during the past year the work was severely handicapped by the fact that the driving clock was undergoing repair. Last summer the objective prisms were adjusted, and about eighty stellar spectra were obtained, sixteen of which are of use for measurement ; but later the driving worm had to be dismounted and sent to Dublin. Using a single prism, the spectrum beween F and H is 2 inches long. In a photograph of Vega with an exposure of nine minutes the hydrogen lines up to ζ (Huggins's notation) were obtained, the spectrum between F and ζ being 3 inches in length. With both prisms the dispersion is very great, the spectrum more than covering the length of the photographic plate used (length between Hγ and H is 1·75 inches). The necessity of having to send the driving worm of the new clock away to be re-cut, in addition to making several instrumental tests, seems to have taken up much of the time that might have been used in observing. The fifth satellite of Jupiter is within the reach of this instrument, and has been seen on two occasions, January 24 and February 4, Mr. Newall remarking that "it has been most justly described as a very difficult object."

JOHNSTON'S NOTES ON ASTRONOMY.—Under this title we have before us a small book, by Swift P. Johnston, edited by James Lowe, consisting of about eighty pages, dealing with the more purely elementary mathematical portion of astronomy. The book is a compromise between a popular work and a text-book for students, and links the one to the other. Coming out originally in the form of notes, the present edition has been widely expanded, and may now be said to form an excellent course of astronomy for beginners. It is simple-worded and concise, and presents the reader with a general sketch of the more important problems which is the part of the science of astronomy to solve. The diagrammatical figures supplement and render more clear various parts of the text, and the 150 excellent questions, if fully answered by the reader, would prove a very serviceable addition to his astronomical education.

THE HODGKINS FUND PRIZES.—The following prizes are announced by the Smithsonian Institution with the intention of furthering the wishes of Mr. Thomas Hodgkins, who we have previously referred to as having presented a large donation to the institution for the "increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man" :—

(1) $10,000 for a treatise embodying some new and important discovery in regard to the nature and properties of atmospheric air. These properties may be considered as bearing upon all or any of the sciences, *e.g.* not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical science.

(2) $2000 for a satisfactory essay on : (*a*) The known properties of atmospheric air considered in their relationship to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships. (*b*) The proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. The essay as a whole should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation.

(3) $1000 for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length.

All these treatises may be written in English, French, German, or Italian, and sent to the secretary of the Smithsonian Institute, Washington, before July 1, 1894, with the exception of those in competition for the first prize, which will be delayed until December 31, 1894. Further information on the above and other points, such as the giving of medals, &c., may be obtained from the secretary's report, and also from *Astronomy and Astrophysics*, No. 116, p. 560.

GEOGRAPHICAL NOTES.

AT the meeting of the Royal Geographical Society, held on June 26, Captain F. R. Maunsell gave an account of his journeys in Kurdistan during the summer of 1892. Kurdistan is not an accurately-defined province, but may be described as the extensive district inhabited by the Kurds, embracing the region of Lake Van and the Upper Euphrates, as well as the country between the Tigris and the Persian frontier south of Lake Van. Captain Maunsell entered Kurdistan from the north, passing Erzingan and Erzerum, and skirted the eastern shore of Lake Van. The watershed between the lake and the Tigris Valley is very low, but it is not easy to discover any place at which there might at some former time have been an outlet. It seems not unlikely that a lava overflow from the volcano Mount Nimrud, on the western shore of the lake, cut off the plain of Van from the Tigris, and thus formed the lake. Captain

Maunsell descended to the Tigris, and followed that river to its mouth, making excursions into the mountainous country to the east. Only in southern Kurdistan is the population exclusively Kurdish. North of Mosul there is a considerable Christian element. Not many years ago Kurdistan was a separate province, ruled over by Kurdish beys, whose strongholds were Amadia, Rawanduz, Sulaimanie, and other places. But all this is changed, and the country is now under the direct control of Turkish officials. The original Kurdish organisation was tribal, and the prevailing habits of the tribes are still nomadic and pastoral, but have been modified by local conditions. Thus, the Kurds of the mountainous district north of Lake Van remain in villages all through the severe winter, the great distance being a bar to migration into a warmer plain country. In the summer, however, they leave their village dwellings for their tents, which they often pitch close to their winter home. In the rugged Dersim country the Kurds are perforce sedentary. In central and southern Kurdistan the tribes have easy access to the Mesopotamian plain, and a large number of them live in tents all the year round.

At a special meeting of the Royal Geographical Society held on Monday at London University, Burlington House, it was decided, by 172 to 158 votes, that it was inexpedient to admit ladies as ordinary Fellows of the Society.

A Dalziel's telegram says that Lieutenant Peary, with Mrs. Peary and twelve companions, left New York on July 2 in the whaling barque *Falcon*, on his second expedition to the Arctic regions.

MUSEUMS ASSOCIATION.[1]

I.

The Museums Association is one of the youngest of the numerous social organisations which it is thought expedient at the present day to constitute in order to give facilities for the interchange of ideas on subjects interesting to a special group of men. It is, indeed, only in the fourth year of its existence, and this is the first time that a meeting has been held in London, the centre in which are gathered the great national collections, and in which reside so considerable a number of persons engaged in their custody. The association claims York as its birthplace, and Liverpool, Cambridge, and Manchester have in succession afforded it hospitality and enjoyed the advantage of its presence.

We all meet with one object in view. We are all impressed with the value—with the necessity, I should say—of the Museum (using the word in its widest sense, as a collection of works of art and of nature) in the intellectual advance of mankind.

How could art make any progress, how could it even exist, if its productions were destroyed as soon as they were created; if there were no museums, private or public, in which they could be preserved and made available to mankind then and thereafter? How could science be studied without ready access to the materials upon which knowledge is built up? In many branches of science the progress is mainly commensurate with the abundance and accessibility of such materials.

Though the first duty of museums is, without question, to preserve the materials upon which the history of mankind and the knowledge of science is based, any one acquainted with the numerous succession of essays, addresses, lectures, and papers which constitute the museum literature of the last thirty years must recognise the gradual development of the conception that the museum of the future is to have for its complete ideal, not only the simple preservation of the objects contained in it, but also their arrangement in such a manner as to provide for the instruction of those who visit it. The value of a museum will be tested not only by its contents, but by the treatment of those contents as a means of the advancement of knowledge. Though this is the general consensus of opinion, as expressed in the literature just referred to, there is naturally still much divergence as to the best methods by which this ideal may be carried out, and there are still many practical difficulties to be overcome before the views so ably advocated on paper can be reduced to the test of actual performance. It is with a hope of assisting in the solution of these difficulties that this Association has been founded.

If in the few words with which I am expected to preface the real work of the Association I shall be found to dwell too exclusively upon the subject of natural history museums, I must apologise to many friends and members of the Association who are present. It must be distinctly understood that under the word museum we include collections of all kinds formed for the advancement of any branch of knowledge, except those specially devoted to books, which already are cared for by the "Libraries Association"—on the model of which ours was formed. I hope that in our papers at this meeting and in future presidential addresses we shall have all branches of museum work fairly represented.

It is my fate to have been born what is commonly called a "naturalist." I hardly remember the time when I was not a possessor of a museum, but it always took a distinctly biological direction. Hence, although by no means unappreciative of other branches of museum work, I shall confine myself chiefly to that part of the subject upon which I can speak from personal experience. Even in this branch time will compel me to limit myself to observations upon some of the larger questions connected with our subject, leaving details for discussion in our subsequent meetings.

One great difference between the work of the curator of an art museum and that of one devoted to what are called natural history subjects, is that in the case of the former the specimens he has to preserve and exhibit come into his hands very nearly in the condition in which they will have to remain. A picture, a vase, a piece of old armour, or a statue, beyond a certain amount of tender care in cleaning and repairing, which is more or less mechanical in its nature, is ready for its place upon the museum shelves. But this is far from being the case with the greater number of natural objects. Not only do they require special methods of preservation, but very often their value as museum specimens depends entirely upon the skill, labour, patience, and knowledge expended upon them. In specimens illustrating biological subjects the highest powers of the museum curator are called forth. A properly mounted animal or a carefully-displayed anatomical preparation is in itself a work of art, based upon a natural substratum. In few branches of museum work has there been greater progress in late years than in this, and few offer still further scope for development.

Partly from this cause, and partly from the fact that art has for a longer period and to a greater degree engaged the attention of civilised man than nature, the method of preservation, arrangement, and exhibition of works of art are on the whole further advanced than are those of natural objects. But no one can deny that there is still in many galleries devoted to the exhibition of works of art of various kinds great room for improvement. There is generally far too great crowding; too many objects so placed that the tallest man cannot see them properly, even when standing on tiptoe; too many others placed so low that they can only be examined by lying down on the floor; too many completely spoiled by the juxtaposition of other incongruous objects, or by unsuitable settings. It is only in a very few public museums (I may instance as a conspicuous example the splendid museum of antiquities at Naples) that the immense advantage to be gained by ample space and appropriate surroundings in aiding the formation of a just idea of the beauty and interest of each specimen contained in it can be properly appreciated. Correct classification, good labelling, isolation of each object from its neighbours, the provision of a suitable background, and above all of a position in which it can be readily and distinctly seen, are absolute requisites in art museums as well as in those of natural history. Nothing detracts so much from the enjoyment and advantage derived from a visit to a museum as the overcrowding of the specimens exhibited. The development of the new museum idea to be spoken of later on will be one way by which this can be remedied in the public galleries; but if museums are what they ought to be, and what I venture to believe they will be in the future, the question of space on a considerably larger scale than has hitherto been thought of will have to be faced. This is of course mainly a matter of expense, and after all but a small matter compared with expenditure now considered necessary in other directions. There are persons who think the country made a tremendous effort in building so much as is yet finished of the new Natural History Museum in the Cromwell Road, and shake their heads at the expenditure

[1] Address of the President, Sir William H. Flower, K.C.B., F.R.S., &c. London Meeting, July 3, 1893.

asked for either to complete that establishment by the erection of the wings at the sides, or to finish the neighbouring South Kensington Museum in such a manner as worthily to hold its collections, both of art and science; or who would deprecate the further expansion of the magnificent series of treasures of ancient and mediæval art in the British Museum at Bloomsbury, of which the country has such just reason to be proud. Let such persons consider that the largest museum yet erected, with all its internal fittings, has not cost so much as a single fully-equipped line-of-battle ship which in a few years may be either at the bottom of the sea, or so obsolete in construction as to be worth no more than the materials of which it is made. Not that I am deprecating the building of ships necessary for our protection, but rather wishing to show that the cost of such museums as are still required for the proper education of the nation is not such as would produce any sensible impression upon its financial position.

I may make a still more apposite comparison, and point to the vast sums of money spent by this nation upon the whole subject of education now and a few years ago. The total estimate for what is called "Class IV., Education, Science and Art," for the financial year 1883–84, amounted to £4,748,556. In ten years it has grown to nearly double that amount, the estimate for 1893–94 being £9,172,216, the increase being mainly due to what is termed "Public Education." The amount spent upon the development of museums is comparatively insignificant. The British Museum vote (including the library and the natural history branch) has only increased from £146,019 to £157,500. The cost of the various museums maintained by the Science and Art Department shows little appreciable augmentation, except in the case of that at Dublin, where I am glad to see £19,035 is now put down instead of the £13,602 of the former period. Compared with the whole amount expended upon other methods of education, national expenditure upon museums and art galleries is at present very small.

In reference to this subject one cannot help considering how much might have been done if only a moderate portion of that large sum of money obtained a few years ago by the tax on brewers, and handed over to the County Councils to spend in promoting technical education, had been used for erecting museums, which might have taken a permanent place in the education of the country. Every subject taught, in order to make the teaching real and practical, should have its collection, and these various collections might all have been associated in the county museum under the same general management. The staff of teachers would assist in the curatorial work, and thus a well-equipped central college for technical education might have been formed in every county, sending out ramifications into the various districts in which the need of special instruction was most felt, and being also the parent of smaller branch museums of the same kind wherever they seem required.

But it is not only in the buildings that the expense of the museums of the future will have to be met. Another great advance will have to be made before they can be placed upon a satisfactory footing, and perform the functions that can be legitimately expected of them. This is in the elevation of the position and acquirements of those who have the care of them. As I have said on a previous occasion, "What a museum really depends upon for its success and usefulness is not its building, not its cases, not even its specimens, but its curator."

Speaking in the presence of a number of gentlemen who are curators of museums, do not let me be misunderstood. I do not mean that you are not zealous in the cause and make great sacrifices for it, and do all you can under the often difficult circumstances in which you are placed; but what I mean is—and I am sure you will one and all agree with me when I say it—you are not properly appreciated by the public, and the importance and difficulties of your position are by no means sufficiently understood. In a civilised community the necessities of life, to say nothing of luxuries (which we do not ask for), but the bare necessities of a man of education and refinement, who has to associate with his equals, and bring up his children to the life of educated and refined people, involve a certain annual expenditure, and the means afforded by any occupation for this necessary expenditure gives a rough and ready test of the appreciation in which such occupation is held.

Now, a curator of a museum, if he is fit for his duties, must be a man of very considerable education as well as natural ability. If he is not himself an expert in all the branches of human knowledge his museum illustrates, he must be able to understand and appreciate them sufficiently to know where and how he can supplement his own deficiencies, so as to be able to keep every department up to the proper level. His education, in fact, must be not dissimilar to that required for most of the learned professions. Still, manual dexterity and good taste are also most valuable. He must, in addition, if he is to be a success in his vocation, possess various moral qualifications not found in every professional man—punctuality, habits of business, conciliatory manners, and, above all, indomitable and conscientious industry in the discharge of the small and somewhat monotonous routine duties, which constitute so large a part of a curator's life. Such being the requirements of the profession, let us see what are the inducements offered to men to take it up as a means of livelihood. I really am sorry to have to speak of such a sordid subject, but I know it is one you naturally shrink from talking of yourselves. You would be the last people in the world to take the remedy, so often now resorted to by other classes, into your own hands. A strike of curators is hardly to be contemplated. Remember, now, that I am not speaking of this subject in your interests, or the interests of any individuals. Whether any of you personally should have your emoluments, your social position, your opportunities for good, improved, is not now with me an object of concern, it is in the interest of that great question, the advance of the museum as a means of educating, cultivating, and elevating mankind, that I am speaking, an advance that can only be effectively made when the curatorship of a museum is looked upon as an honourable and desirable profession for men of high intellectual acquirements.

Let me take a few examples of the inducements to enter this profession at the present time. I have before me some recent advertisements. The curator of the Museum of the Philosophical and Literary Society of one of the largest and most flourishing of our manufacturing cities is offered £125 a year for his services. In another town, smaller and less wealthy, it is true, "a resident curator, meteorological observer, and caretaker, is wanted for the museum and library buildings at a salary of £50 per annum, with rooms, coal, and gas. Applicants are to state age and scientific qualifications."

In a recent newspaper discussion upon the establishment of a museum in one of the midland counties, after it had been pointed out that one of the prime necessities of such an institution was a provision for the maintenance of a curator, a leading gentleman of the district, a zealous and sympathetic advocate of the cause, perfectly acquiescing in this view, suggested that £100 a year should by all means be set aside for this purpose.

It is frequently my lot to be consulted by anxious parents of sons who develop a taste for museum work as to what such a taste will lead to if cultivated. I need hardly say that, however much I may wish our ranks to be recruited by such enthusiastic aspirants, boys often of great ability and promise, I cannot conscientiously offer much encouragement. The best I can say is that I hope things will be better in the future than they are at present. As far as the Metropolis is concerned there has been some improvement, and I think that indications are not wanting that this improvement will continue and extend.

I have referred at the beginning of this address to the great amount of recent literature upon the museum question, consisting chiefly in depreciation of the old ways of arranging museums, of suggestions for the improvements for the future, and mainly in the development of what may be called the new museum idea. What this idea is was tersely expressed nearly thirty years ago by the late Dr. John Edward Gray, in his address to the British Association at Bath (1864) as President of Section D, when near the close of his long career as administrator of a collection which by his exertions he had made the largest of the kind in the world, he laid down the axiom that the purposes for which a museum was established were two—"first, the diffusion of instruction and rational amusement among the mass of the people, and, secondly, to afford the scientific student every possible means of examining and studying the specimens of which the museum consists." He then continued—"Now, it appears to me that in the desire to combine these two objects, which are essentially distinct, the first object—namely, the general instruction of the people—has been to a great extent lost sight of and sacrificed to the second without any corresponding advantage to the latter, because the system itself has been thoroughly erroneous."

This was a remarkable admission, coming from a man who had been brought up in, and had acted throughout the whole of his life upon, the old idea; but it clearly expressed what was then beginning to be felt by many who turned their unbiassed attention to the subject, and it is the keynote of nearly all the museum reforms of recent date. During the long discussion which followed, the new idea found powerful advocates in Huxley, Hooker, Sclater, Wallace, and others; but Owen, whose official position made him the chief scientific adviser in the construction of the new National Museum of Natural History, never became reconciled to it, and, unfortunately, threw all the weight of his great authority into the opposite scale.

The method of application of this principle depends entirely upon the general nature of the museum, whether that of a nation, a town, a school, or a society or institution established to cultivate some definite branch of knowledge. It is mainly of national museums that I am speaking at present, and it is only in national museums that the fulfilment of both functions in fairly equal proportions can be expected. In almost all other museums the diffusion of knowledge or popular education will be the primary function, and if the true principles of arrangement of such museums be once grasped, this is a function which can be carried out upon the largest or the smallest, or any intermediate scale, according to the means of the institution and requirements of the locality.

The collections for the advancement of science, on the other hand, are of value mainly in proportion to their size, and no museum at present existing has come anywhere near what is required for the exhaustive study of natural history. If any one were now to endeavour to write a complete monograph of any family in the animal kingdom, he would search in vain for materials for doing so, not only in any one museum, but in all the museums in the world put together.

Soon after the arrival in our Natural History Museum of the great and carefully selected and labelled collection of Indian birds, presented by Mr. A. O. Hume, containing upwards of 60,000 specimens, a well known ornithologist commenced the volumes devoted to birds in the excellent series of manuals on the fauna of British India, edited by Mr. Blanford. I am told that when he began the work he was seen sitting at his table rubbing his hands with delight at the prospect of success in his labours guaranteed by such an unprecedented mass of material. But after a few weeks the scene had changed. He was pacing up and down the room, wringing the same hands in despair at the hopelessness of solving the tangled problems of the variation according to age, sex, season, and locality, the geographical distribution, and the limits and relationship of any single species, owing to the absolutely insufficient number of properly authenticated specimens at his command. Every zoologist will recognise this as a scarcely exaggerated description of what he meets with at every step of his work. Except, perhaps, for some special and limited groups, which may be taken up in private collections, a national museum alone can possibly attempt to bring together the materials required for such exhaustive work, but it is undoubtedly the duty of all national museums to endeavour to do this. There should be in every great nation one establishment at least where problems may be attacked with some prospect of success, and the only conditions upon which collections for this purpose can be maintained are that they should be so arranged as to occupy the smallest possible space compatible with their proper preservation and convenience of access; and that they should be removed from all the deteriorating influences of light and dust, and at the same time be perfectly available for the closest examination by all those whose knowledge is sufficient to enable them to extract any information from them. This means that they cannot be *exhibited* in the ordinary sense of the word; although it must not be supposed that they are on that account in less need of orderly and methodical arrangement. There is certainly a danger of collections which are not generally exhibited becoming neglected, and degenerating into the condition of mere accumulations of rubbish. Anything of the kind is absolutely incompatible with the true requirements of specimens kept for research. They specially need to be arranged in an orderly and methodical manner, and to be thoroughly well catalogued and labelled, so that each may be found directly it is wanted, and to be frequently inspected to see that they are free from moth or other deleterious influence. The object of keeping them in this condition is, indeed, that they should be preserved and not destroyed, as many exhibited specimens ultimately are. Much curatorial ingenuity may be exercised in the methods of stowing and arranging such specimens to the best advantage. The conditions of access to them will be precisely those now accorded to books or manuscripts in a library, prints and drawings in an art museum, the records and public documents in the Rolls Office or Somerset House.

As the actual comparison of specimen with specimen is the basis of zoological and botanical research, and as work done with imperfect materials is necessarily imperfect in itself, it is far the wisest policy to concentrate in a few great central institutions the number and situation of which must be determined by the population and resources of the country, all the collections (especially those containing author's types or the actual specimens upon which species have been established, and which must be appealed to through all time to settle vexed questions of nomenclature) which are required for the prosecution of original research. It is far more advantageous to the investigator to go to such a collection, and take up his temporary abode there while his research is being carried out, with all the material required at his hand at once, than to travel from place to place and pick up piecemeal the information he requires, without opportunity of direct comparison of specimens.

On the other hand, in local museums, such collections are not only not required, but add greatly to the trouble and expense of the maintenance of the institution, without any compensating advantage. Here it will be the duty of the curator to develop the side of the museum which is educational and attractive to the general visitor, and to all who wish to obtain that knowledge, which is the ambition of many cultivated persons to acquire without becoming a specialist or expert. The study of the methods by which such museums may be made instructive and interesting offers an endless field for experiment and discussion, and the various problems connected with it are treated of not only in the literature I have referred to, but in a more practical manner in many museums in various parts of the world.

Without pursuing this question further at the present time, I should like to repeat from a previous address on the same subject[1] certain propositions which are fundamental in the arrangement of collections of the class of which I am now speaking.

The number of the specimens must be strictly limited, according to the nature of the subject to be illustrated, and the space available. None must be placed either too high or too low for ready examination. There must be no crowding of specimens one behind the other, every one being perfectly and distinctly seen, and with a clear space around it. If an object is worth putting into a gallery at all, it is worth such a position as will enable it to be seen. Every specimen exhibited should be good of its kind, and all available skill and care should be spent upon its preservation, and rendering it capable of teaching the lesson it is intended to convey. Every specimen should have its definite purpose, and no absolute duplicate should on any account be admitted. Above all, the purpose for which each specimen is exhibited, and the main lesson to be derived from it, must be distinctly indicated by the labels affixed, both as headings of the various divisions of the series and to the individual specimens.

(*To be continued.*)

MARINE BIOLOGICAL ASSOCIATION.

THE report of the Marine Biological Association of Great Britain was read at the annual meeting of the Association held in the rooms of the Royal Society on June 28. From it we learn that the buildings, fittings, and machinery of the Plymouth laboratory are in a satisfactory condition, and have not necessitated any special outlay.

The question of the boats has occupied the council very seriously during the past year. The old steam-launch *Firefly* is still at work, although it was decided to replace her a year ago. A new steam-launch, of about the same size as the *Firefly*, was recently purchased, but has proved to be unsuitable for rough work. The little sailing-boat, *Anton Dohrn*, is in excellent repair, and continues to be very useful.

The need of a deep-sea-going boat has become most pressing, but there are no funds in hand sufficient for its purchase and maintenance. This need has been particularly felt of late in the fishery inquiries in which the Association has been engaged in the North Sea as well as at Plymouth.

The type-collection is increasing satisfactorily under Mr. Garstang's care. In addition to the specimens at Plymouth, a

1 British Association for the Advancement of Science. Report of Newcastle Meeting, 1889.

series of selected specimens has been arranged and exhibited at various *soirées*. This exhibition series is being enlarged.

Owing to the generosity of Mr. J. P. Thomasson, who has made a second donation of £250 for this purpose, it has been possible for the council to retain the services of Mr. Holt for fishing inquiries in the North Sea for a second year.

Mr. Garstang has been appointed for a second year to superintend the collection, preservation, and supply of material. The character of the specimens supplied by the laboratory has improved very greatly under his care.

Mr. Cunningham has continued his observations on the rate of growth and probable ages of young fish, a paper on which was published in the November number of the Association's journal. He has also continued his experiments on the colouration of the under-side of flat-fishes. Since Christmas he has been occupied in an inquiry into the question of the destruction of immature fish, the first results of which appear in the May number of the journal.

Mr. Cunningham has also succeeded in artificially fertilising the eggs of the flounders which he has reared in the laboratory tanks during the last three years from a length of half an inch; the eggs developed, and the larvæ were artificially fed for ten days after the absorption of the yolk-sac. This result is of great importance and interest.

Mr. Holt has been at work now for eighteen months upon an investigation of the fisheries of the North Sea, and his papers in the journals for November and May supply a large amount of important information. The Council contribute to the expenses of the Cleethorpes Aquarium of the Marine Fisheries Society (Grimsby) in return for Mr. Holt's use of their laboratory and tanks.

Mr. Garstang has captured a large number of rare forms during the past year, and he has added five new species to the list of the British fauna. As a result of his work during the past year, an intimate knowledge of the localities of the fauna has been acquired, so that specimens can be obtained without delay.

The receipts for the past year include the annual grants from H.M. Treasury (£1000) and the Worshipful Company of Fishmongers (£400); annual subscriptions have produced £160, composition fees £16, the rent of tables at the laboratories, £34, the sale of specimens £205, and the admission to the tank-room £70, the total amounting, with lesser sums, to £2199.

The Vice-Presidents, Officers, and Council proposed by the Council for 1893–94 are:—President: Prof. E. Ray Lankester, F.R.S.; Vice-Presidents: The Duke of Argyll, K.G., K.T., F.R.S., the Duke of Abercorn, K.G., C.B., the Earl of St. Germans, the Earl of Morley, the Earl of Ducie, F.R.S., Lord Walsingham, F.R.S., Lord Revelstoke, the Right Hon. A. J. Balfour, M.P., F.R.S., the Right Hon. Joseph Chamberlain, M.P., Prof. G. J. Allman, F.R.S., Sir Edward Birkbeck, Bart., M.P., Sir Wm. Flower, K.C.B., F.R.S., the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., Prof. Alfred Newton, F.R.S., Sir Henry Thompson, Rev. Canon Norman, F.R.S., Captain Wharton, R.N., F.R.S.; Council—elected Members: F. E. Beddard, F.R.S., Prof. F. Jeffrey Bell, Prof. W. A. Herdman, F.R.S., Sir John Evans K.C.B., F.R.S., A. C. L. G. Günther, F.R.S., Prof. A. C. Haddon, Dr. Sydney J. Hickson, Prof. W. C. McIntosh, F.R.S., Right Hon. E. Majoribanks, M.P., E. B. Poulton, F.R.S., P. L. Sclater, F.R.S., Adam Sedgwick, F.R.S., Prof. Charles Stewart, Prof. W. F. R. Weldon, F.R.S., Hon. Treasurer: E.L. Beckwith; Hon. Secretary: G. Herbert Fowler.

THE CONDITIONS DETERMINATIVE OF CHEMICAL CHANGE.[1]

NOTWITHSTANDING the large amount of evidence now placed on record that substances commonly supposed to be capable of directly interacting do so only in the presence of at least one other substance, chemists do not appear to have arrived at any clear and consistent understanding of the conditions determinative of chemical change: as each fresh case is recorded, we continue to express surprise, overlooking the fact that Faraday, in his early "Experimental Researches in Electricity," clearly foresaw what the conditions were, and that but a slight extension of his generalisations is needed to frame a comprehensive theory. The subject is of such importance that it appears to me desirable to discuss the bearing of recent observations, especially as they to some extent necessitate the modification of views that I have expressed elsewhere, and in order to attract the attention of physicists, to whom we must now look for guidance in these matters.

Eight years ago, in the course of the discussion on Mr. H. B. Baker's communication on combustion in dried gases (Proc. Chem. Soc., 1885, 40), I defined chemical action as *reversed electrolysis*: in other words, in order that chemical action may take place, it is essential that the system operated on comprise an electrolyte. I then pointed out that as neither hydrogen nor oxygen was an electrolyte, a mixture of only these two gases should not be explosive; and, moreover, as water was not an electrolyte, and it was scarcely probable that water and oxygen or hydrogen would form an electrolyte, it was difficult to understand how the presence of water pure and simple should be of influence in the case of a mixture of hydrogen and oxygen. This forecast has since been verified, the remarkable series of experiments carried out by V. Meyer in conjunction with Krause and Askenasy having clearly demonstrated that the formation of water from hydrogen and oxygen takes place at an irregular rate, and is, therefore, dependent on the presence of a something other than water—I imagine an acid impurity. But this is a consideration which has not yet received the proper attention, and it is, therefore, desirable to emphasise its importance by reference to other cases. Mr. Baker's recent preliminary note on the influence of moisture in promoting chemical action (*ante*, p. 229) affords several interesting examples:—Thus, he states that neither does hydrogen chloride combine with ammonia, nor is nitric oxide oxidised by oxygen if moisture be excluded. In the former case, the addition of water should suffice to determine the combination, as water and hydrogen chloride together form a "composite electrolyte" (*cf.* Roy. Soc. Proc., 1886, No. 243, p. 268); as neither nitric oxide nor oxygen, however, forms a composite electrolyte with water, in this case water alone should not determine the occurrence of change; but if, by the introduction of a trace of "impurity" in addition to water the presence of a composite electrolyte were secured (however high its resistance, owing to the smallness of the amount of "impurity"), action would set in, and when once commenced would proceed at an increasing rate, as nitric acid would be formed and the resistance of the electrolyte would consequently diminish. On this account it will be a task of exceeding difficulty to experimentally demonstrate that nitric oxide and oxygen are inactive in presence of water alone; but there can be no doubt that such must eventually be admitted to be the case, provided always that it is permissible to extrapolate Kohlrausch's observations, and to conclude from them that *pure* water is a dielectric. The gradual increase in the rate of change here contemplated corresponds to the period of induction observed by Bunsen and Roscoe in their observations on the interaction of chlorine and hydrogen; the statement recently made by Bodenstein and V. Meyer (*Berichte*, 1893, 1146) that a mixture of chlorine and hydrogen behaves irregularly on exposure to light is a valuable confirmation of Pringsheim's observations, and there is now no room for doubt that *pure* chlorine and hydrogen would be incapable of interacting. That no such irregularity is observed on heating iodine with hydrogen is not surprising, as hydrogen iodide would be formed from the very outset, and the electrolyte present would exert a minimum resistance almost at once. There is, however, a significant difference in the behaviour of the two mixtures, as hydrogen chloride should behave as hydrogen iodide, so that the problem is but incompletely solved: it may be that the one mixture was more nearly pure than the other, or it may be that the formation of hydrogen chloride from hydrogen and chlorine, under the influence of light, is dependent on the presence of some particular substance, together with water, and does not take place under the influence of any substance capable of forming a composite electrolyte with water; probably, however, the difference observed is chiefly due to the fact that only one of the actions is reversible under the conditions prevailing in the experiments.

Lastly, attention may be directed to the formation of sulphuric oxide from sulphurous oxide and oxygen, which is readily effected in presence of a catalyst, such as finely divided platinum; it cannot be supposed that the mere presence of platinum would condition the occurrence of change, and doubtless moisture is also necessary, the platinum or other catalys

[1] Reprinted from the Proceedings of the Chemical Society, No. 125.

but serving to promote the oxidation of the sulphurous oxide at a temperature considerably below that at which sulphuric oxide decomposes when heated. The action of surfaces generally may well be of this character, and the converse influence they so frequently exercise is probably an effect of the same order.

I have elsewhere raised the question whether there may not be a difference between actions taking place under the influence of low and of high electromotive forces—whether water, *per se*, may not be an electrolyte towards high, although not towards low, forces, in the case of high temperature changes, or those brought about under the influence of the electric spark, for example. More attentive consideration of the subject has led me to think that this is not the case, and that we must treat high temperature changes such as occur and are involved in gaseous explosions in the same way as those occurring under ordinary conditions and at low temperatures. From this point of view, Mr. Baker's statement that ammonia and hydrogen chloride do not combine is of extreme importance; the formation of ammonium chloride from these two compounds apparently involves no interchange, but a mere combination of two substances each endowed with considerable "residual affinity," and there is no reason why a distinction should be drawn between such a case and that afforded by, say, *atoms of hydrogen and oxygen*, the difference being, it would seem, one of degree only; in fact, I am no longer inclined to believe that atoms are capable of directly uniting. In all cases at least one function of the (composite) electrolyte would appear to be that of providing the necessary "mechanism" whereby the degradation or discharge of the energy is effected. If this argument be sound, its logical extension involves the conclusion that *pure* gases should be dielectrics, *i.e.* that the passage of an electric discharge through a gas like that of an explosive wave through, say, a mixture of hydrogen and oxygen, can only take place if an electrolyte be present. Hitherto but little attention has been paid to the electric discharge in gases which have been highly purified. The peculiar behaviour of Tesla tubes referred to by Mr. Crookes in the discussion on Mr. Shenstone's paper on the formation of ozone is, perhaps, explicable from this point of view—it may be that the atmosphere within the tube does not become conducting until sufficient moisture and "impurity" have been projected from its sides. It is conceivable that a similar explanation may hold good in the case of Prof. Schuster's observation, that it is possible to urge a current of low electromotive force across a gas subjected to a high electromotive force in itself insufficient to cause a discharge in the gas; the atomic dissociation hypothesis put forward in explanation of the phenomenon does not appear to me to be sufficient.

Finally, the question arises, Can no line be drawn; are no two pure substances capable of combining or interacting:—For example, water and sulphuric anhydride? There is little to guide us here, but it seems not unlikely that water has special properties which enable it to act directly; moreover—perhaps because—in such cases composite electrolytes would result. Ammonium chloride, so long as it remains solid, is clearly a compound of a different order, and it may well be that compounds of this type are in no case directly obtainable from their constituents, because, under the conditions under which they are formed, they cannot behave as electrolytes.

Apparently, in all cases in which molecular aggregates are formed—as in the case of solutions—we are dealing with dissociable and dissociating systems, and it is not improbable that we may ultimately find an explanation of the mechanism of such changes in this fact.

At present there is no information forthcoming whether simple electrolytes, such as fused silver chloride, for example, will condition chemical change in the way that water does—whether, for instance, silver chloride will condition the formation of hydrogen chloride from chlorine and hydrogen, so that a gas battery might be constructed of these three substances.

HENRY E. ARMSTRONG.

THE SUCCESSION OF TEETH IN MAMMALS.

PROF. H. F. OSBORN, in the *American Naturalist* for June, gives an account of recent researches upon the succession of the teeth in mammals. He says:—

"The recent studies of Kükenthal, Röse, and Taeker in the discovery of the complete double or milk dentition in the Marsupials, and in the discussion of its relation to that of the reptiles, also in the ontogenesis of the crowns of the teeth among the Cetaceans, Edentates, Primates, and Ungulates are of the greatest interest and importance. They involve a complete revolution in our ideas as to the interpretation of the dentition in the three orders first mentioned above."

After giving an account of the work done by the European observers, Prof. Osborn shows, by means of a table, the phylogenetic order as observed by Cope and Osborn, and the ontogenetic order as observed by Röse and Taeker. His researches indicate that the earliest forms of mammals were homodont, and had two or more series of successional teeth. Then within the mammalian stem the teeth were differentiated, and there arose a great heterodont group with teeth at least of three kinds—incisors, premolars, and molars, all successional. From the most anterior premolar arose the canine. Then came the division between the Marsupials and the Placentals, the former tending to suppress the development of the second series of teeth, the latter retaining the second series as far back as the first molar. There is an obvious advantage in the line of succession being drawn at the first molar,[1] for upon the molars rested the necessity of complex development, and such development was best effected in permanent crowns.

1. All the so-called "milk molars" plus the so-called "true molars" constitute the *first series*. Beneath one or more of the "true molars" in lower mammals are rudiments of a second series. The *second series* consists therefore of these submolar rudiments plus the successional or permanent premolars, incisors and canines.

2. In the stem Marsupials the entire first series persisted and became mainly permanent (non-deciduous); the second series became rudimentary and non-successional with the exception of the fourth upper and lower premolars, and possibly one or two other teeth which either replaced or were intercalated between members of the first series. One or more premolars were suppressed, and one more molar retained than typical in the Placentals. Thus is explained the apparently atypical dental formula of Marsupials.

3. In the stem heterodont Placentals (excepting the Cetacea and Edentata) the entire first series persisted, and all the incisors, canines, and premolars remained deciduous. The successional second series persisted as far back as the first molar.

4. In the stem Cetacea the entire first series persisted, and the second series became rudimentary and non-successional. The tooth form changed from a heterodont to a homodont type.

5. In the stem Edentates, which also transformed from the heterodont to the homodont type, the first series became rudimentary, and the second series persisted in the succession even behind the region of the first molar.

Finally, there is evidence that a primitive succession in the region of the molar teeth, lost in the Marsupials and in the Placentals, was more or less fully retained in the Cetacea and Edentates.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Governors of the Glasgow and West of Scotland Technical College have appointed Mr. W. H. Watkinson, lecturerer on engineering, Central Higher Grade School, Sheffield, to the Chair of steam, steam engines, and other prime movers, recently instituted in the college. By several important changes, the engineering department has been recently reorganised, Prof. Jamieson devoting his attention entirely to electrical engineering, Prof. Rowden to mechanics (theoretical and applied), Prof. MacSay to machine drawing, and Prof. Watkinson to the subjects stated above. With this addition and rearrangement the college now possesses an engineering staff worthy of one of the greatest engineering centres in the kingdom. Many additions are wanted, however, to bring the laboratories and general equipment to a position of equality with those even in many provincial towns.

[1] The law of molar evolution is that complication is most rapid in teeth which are longest in use. Thus the first molar is the most progressive tooth of the true molar series, and the last premolar is the most progressive of the premolar series. The apparent exception that the third milk premolar is always an advance type of the third permanent premolar is explained by the fact that the milk premolars are formed to assume the molar function

We have received from the Cambridge University Extension authorities the detailed programme of their summer meeting. Courses of study extending over a month (from July 29 to August 26 inclusive) have been arranged, intended primarily for those connected in some way with the University Extension Movement, though all members of the teaching profession and other students are also admitted. Though the full course extends over a month it has been arranged that those who can only spare a fortnight shall have a fairly complete course of work to go through. The subjects on which instruction is offered are extremely varied, including history, literature, and language, art, economics, and natural science. On the scientific side several courses of laboratory work are provided and in addition there are to be a set of lectures illustrating, from the history of several sciences, the progress and methods of natural science. The services of Sir Robert Ball, Sir Henry Roscoe, and a number of other well-known lecturers have been secured. Many intending visitors will be glad also to see that the authorities have not forgotten that August is a time for recreation as well as study and have made special arrangements for boating, for admission to college gardens, as well as for several excursions to places of historic, artistic, or scientific interest. Three colleges have agreed to board students at extremely moderate rates, and there is an abundance of lodgings. The total expense of the month for a student living economically need not exceed £6 or £7. There are probably not many other ways in which such a pleasant and profitable holiday can be spent for so small a sum.

THE following elections to natural science scholarships at Oxford have been announced :—Mr. H. C. H. Carpenter, of Eastbourne College, to a Natural Science Postmastership at Merton College. Mr. T. J. Garstang, of Manchester Grammar School, to a Natural Science Scholarship at Corpus Christi College. Mr. Richard Warren, of the Charterhouse, to an Open Natural Science Scholarship at New College. In each case the value gained is £80 per annum.

SUMMER courses seem to be the order of rhe day. The Marine Biological Laboratory at Woods Holl, Massachusetts, was opened on June 1, and will remain open until August 30. The Laboratory has aquaria supplied with running sea-water, boats, a steam launch, collecting apparatus, and dredges. There are thirty-three private laboratories for investigators, and five general laboratories. Short courses has also been arranged in zoology and botany, the laboratory work in each case being accompanied by lectures. Every facility is given for the obtain- of general knowledge, while those who are prepared to begin original work, under the guidance of instructors, are provided for as well as the practised investigator. This classification of workers into three grades is an excellent one and well worthy of imitation.

COL. SIR CHARLES W. WILSON, F.R.S., has been appointed Honorary Master of Engineering of the University of Dublin.

SCIENTIFIC SERIAL.

American Meteorological Journal, June.—The principal articles are : Note on the relation of solar spots to terrestrial anticyclones, by A. Searle. The relation considered is not one of cause and effect, but simply an analogy recently suggested in the *Astronomische Nachrichten*, by E. von Oppolzer, whose idea is to substitute the anticyclone instead of the cyclone as is usually done, as the terrestrial term of the comparison. The author considers the comparison to be both striking and plausible, but Prof. Davis thinks it should be limited to terrestrial anticyclones during winter nights.—A new series of isanomalous temperature charts, based on Buchan's isothermal charts, by S. F. Batchelder. The author has constructed a new set of isabnormal charts, based on the observations of the *Challenger* expedition, which are said to show more plainly than those of Humboldt and Dove the departures from the average temperature of a parallel of latitude. The cold area on the west coast of South America is found to be 10° too cool, instead of 6°·7 ; that on the west coast of Africa to be 6° instead of 4°·5. The excess of heat of Southern Alaska is given as 10° instead of 6°·7, and the south coast of Norway (under the influence of the Gulf Stream) is found to be 23° over the average for the latitude, instead of 20°·3, while the cold areas in the interior of North America and Asia, given as 11°·3 by Dove, are now shown to be 14° below the mean temperature of their latitude.—Proposed subjects for correlated study by State Weather Services, by W. M. Davis. The non-telegraphic records are almost entirely reduced in an arithmetical manner, suitable for the determination of climate, but not for the determination of unperiodic factors of the kind with which weather changes are concerned. The author suggests that all observers should make hourly records of the ordinary weather elements on certain days, that these observations should be charted for every hour, and afterwards consolidated on a single map for the whole country, by which means some extremely interesting illustrations of weather phenomena would be gained, and give a better knowledge of processes now imperfectly understood.—Meteorology as the physics of the atmosphere, by W. von Bezold. This concluding part deals more especially with observations made in balloons, and with thermometer exposure. The author thinks it probable that Dr. Assmann's aspirator will show that the temperatures hitherto made in balloons are affected by radiation to the extent of 10° at least. He also gives some valuable advice as to the observation of clouds, and draws especial attention to the importance of observing not only their outward appearance, but more particularly their formation and dissolution, so as to establish their classification and nomenclature upon a natural basis.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"The Experimental Proof that the Colours of certain Lepidopterous Larvæ are largely due to modified Plant Pigments, derived from Food." By E. B. Poulton, F.R.S.

The object of this investigation was to afford a conclusive test as to the theory, previously submitted by the author, that some of the colours of certain Lepidopterous larvæ are made up of modified chlorophyll derived from the food-plant.

Larvæ from one batch of eggs laid by a female *Tryphæna pronuba* were divided into three lots fed (in darkness) respectively throughout their whole life upon (1) green leaves, (2) yellow etiolated leaves, and (3) white mid-ribs of cabbage. The larvæ fed upon (1) and (2) became green or brown as in nature, thus proving that etiolin, no less than chlorophyll, can form the basis of the larval ground-colour. Those fed upon (3), in which neither chlorophyll nor etiolin was accessible, were entirely unable to form the green or brown ground-colour. The production of dark superficial cuticular pigment was, however, unchecked. One of the larvæ fed in this way was perfectly healthy, and had become nearly mature when it was accidentally killed. Many others died early, but resembled that last described in the inability to form a ground-colour.

The experiment seems to leave no doubt as to the validity of the conclusions previously reached. Interesting questions as to the changes passed through by the derived pigments are suggested by this inquiry.

"The Menstruation of *Semnopithecus entellus*." By Walter Heape, Balfour Student at the University of Cambridge. Communicated by Prof. M. Foster, Sec.R.S.

"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part viii. On further Evidences of *Deuterosaurus* and *Rhopalodon* from the Permian Rocks of Russia." By H. G. Seeley, F.R.S.

Royal Meteorological Society, June 21.—Dr. C. Theodore Williams, President, in the chair.—Mr. R. H. Scott, F.R.S., read a paper on fifteen years' fogs in the British Islands, 1876–1890, which was a discussion of the fog observations made at the stations which appear in the *Daily Weather Report*. From the observations it appears that there is no trace of a regular increase either in the monthly or in the annual curve. All that can be said is that taking the three lustral periods of five years each, the last of these, 1886–90, comes out markedly the worst, the successive totals being 262, 250, 322.—A paper on upper currents of air over the Arabian Sea, by Mr. W. L. Dallas, of the Indian Meteorological Office, was also read, in which it is shown that there exists a regular arrangement in the vertical succession of the upper currents, and that the Doldrum region, and not the geographical equator, is really the dividing line between the currents of the northern and southern hemispheres.

PARIS.

Academy of Sciences, June 26.—M. Lœwy in the chair.—On the employment of Lagrange's equations in the theory of impact and percussions, by M. Paul Appell.—Theoretical calculation of the inferior contraction in weirs with thin walls and sheets free below, when this contraction attains its greatest values; with experimental verifications, by M. J. Boussinesq.—Formation of natural phosphates of aluminium and iron; phenomena of fossilisation, by M. Armand Gautier. Aluminium phosphate was formed in the Minerva grotto by the action of ammonium phosphate, resulting from the destruction of a bank of guano, upon a subjacent layer of hydrargilite. This action is easily reproduced experimentally. It is even possible to form a small quantity of aluminium phosphate by the prolonged action of ammonium phosphate upon kaolin. Iron phosphates are produced by the action of ammonium phosphate upon spathic iron ore. This is probably the usual origin of vivianite. It is shown that the simultaneous formation of ammonia, sulphuretted hydrogen, and other products of slow bacterian fermentation, with the action of the air dissolved in water, gives rise, in strata at the same time calcareous and ferruginous, to the simultaneous production of lime phosphates and of pyrites.—Note by M. Daubrée accompanying the presentation, in the name of its authors, of the geological map of European Russia.—Observations of the planet Charlois (1893 Z) made with the 14-inch equatorial of the Bordeaux Observatory by M. L. Picart.—On the maximum modulus which a determinant can attain, by M. Hadamard.—Experimental determination of the constant of universal attraction, and of the mass and density of the earth, by M. Alphonse Berget.—On the third principle of energetics, by M. H. Le Chatelier. The laws of the conservation of mass, of momentum, of quantity of electricity, of the centre of gravity, &c., can be embodied in a single law as follows: The individual "energy capacities" of an isolated system are constant, except that of heat (entropy) which increases in irreversible transformations. This "energy capacity," so termed by Ostwald, is made up of several factors of the type of those enumerated above.—On the employment of mercury in potential equalisers by flow, by M. G. Gouré de Villemontée.—Research on the dielectric constants of some biaxial crystals, by M. Ch. Borel. The principal constants of five rhombic and ten clinorhombic substances were determined by finding their axes of polarisation and measuring their periods of oscillation in a uniform electric field, and also measuring the attraction along each axis of polarisation. The crystals were cut in the shape of spheres. The attraction method was like that used by Boltzmann, except that his bifilar balance was replaced by a unifilar quartz fibre balance. Most of the substances examined were double sulphates. A redetermination of the constants for rhombic sulphur showed a closer agreement with Maxwell's law than Boltzmann's results.—On a new method of directly transforming alternating into direct currents, by M. Charles Pollak.—On the combinations of oxalic acid with titanic and stannic acids, by M. E. Pechard.—Researches on the chlorosulphides of arsenic and antimony, by M. L. Ouvrard.—Action of carbonic oxide upon sodammonium and potassammonium, by M. A. Joannis.—On the combinations of boron bromide with the bromides of phosphorus, by M. Tarible.—On the action of zinc and magnesium on metallic solutions and on the estimation of potash, by MM. A. Villiers and Fr. Borg.—Observations on a marine miocene randannite of the Limagne d'Auvergne, by M. Paul Gautier.—The duration of excitability of the nerves and muscles after death is much greater than is generally believed, by M. A. d'Arsonval. This may be shown by means of the myophone, a kind of microphone arranged so as to indicate small muscular contractions. The instrument gives indications of muscular excitability in a rabbit even ten hours after death.—Remarks on M. d'Arsonval's paper, by M. Brown-Séquard. The fact that a muscle under the influence of complete cadaveric rigidity, remaining perfectly inert under the influence of the strongest impulses provoking contraction, is capable of rhythmic motor actions when its nerve is excited, is one of the most interesting discoveries in the physiology of nerves and muscles.—Sketch of the principal anatomo-pathological types of adult chronic gastritis, by M. Georges Hayem.—Observations on ice, made during the cruise of *La Manche*, by M. G. Pouchet.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Elements of Psychology: Prof. J. M. Baldwin (Macmillan).—Everybody's Guide to Music: J. Booth (Saxon).—A Handbook on the Steam-Engine: H. Haeder, translated by H. H. P. Powles (C. Lockwood).—Murray's Handbook—Switzerland, Savoy, Piedmont, 18th edition (Murray).—University Correspondence College Calendar, 1892-93 (London).—Worked Examples in Co-ordinate Geometry (Clive).—A Biographical Index of British and Irish Botanists: J. Britten and G. S. Boulger (West, Newman).—Foundations of the Atomic Theory (Alembic Club Reprints, No. 2): Dalton, Wollaston, and Thomson (Edinburgh, Clay).—Im Reiche des Lichtes, Sonnen, Zodiakallichte, Kometen: H. Gruson (Asher).—Hourly Meteorological Observations made at the Madras Observatory, January, 1856, to February, 1861 (Madras).

PAMPHLETS.—Sir J. B. Lawes and the Rothamsted Experiments: C. M. Aikman (Glasgow).—U.S. Department of Agriculture: Reports of Observations and Experiments in the Practical Work of the Division (Washington).—Traces of Glacial Man in Ohio: W. H. Holmes (Chicago).—Are there Traces of Man in the Trenton Gravels: W. H. Holmes (Chicago).—Distribution of Stone Implements in the Tide-Water Country: W. H. Holmes (Chicago).—Report and Proceedings of the Ealing Microscopical and Natural History Society for 1892 (Ealing).—Yorkshire Carboniferous Flora: R. Kidston (Leeds).

SERIALS.—Proceedings of the Royal Society of Victoria, Vol. v. new series (Williams and Norgate)—Journal of the Royal Microscopical Society, June (Williams and Norgate).—Journal of the Asiatic Society of Bengal, Vol. lxi. Part 2, No. 3. 1892 (Calcutta).—Journal of the Royal Agricultural Society of England, third series, Vol. 4, Part 2, No. 14 (Murray).—The Botanical Gazette, June (Bloomington, Ind.).—Nyt Magazin for Naturvidenskaberne, 33te Binds, 4de og, 5te Hefte (Christiania).—L'Astronomie, July (Paris).—Himmel und Erde, July (Berlin).—Journal of Botany, July (West, Newman).

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