THURSDAY, APRIL 1, 1897.

A DICTIONARY OF BIRDS.

A Dictionary of Birds. By Alfred Newton, assisted by Hans Gadow, with contributions from Richard Lydekker, B.A., F.R.S., Charles S. Roy, M.A., F.R.S., and Robert W. Shufeldt, M.D., late United States Army. Pp. viii + 124 + 1088. (London: Adam and Charles Black, 1893-1896.)

THE publication of the fourth and concluding part of Prof. Newton's "Dictionary of Birds" places ornithologists in possession of a very useful and concise volume in which is to be found a vast amount of varied information concerning recent and fossil birds, and other matter of wider scope bearing upon variation and kindred subjects.

Many of the articles have already appeared in the ninth edition of the "Encyclopædia Britannica," which was commenced in 1875 and finished in 1888. These in the present volume have been collected together, corrected and expanded to date, and to them have been added a number of additional articles, arbitrarily selected, so the author tells us, but with the main object of supplying useful information on subjects concerning which inquiries are often made but not easily answered.

The articles relating to anatomical subjects are from the pen of Dr. Gadow, and we fully endorse Prof. Newton's appreciation of them. They give in a concise form a mass of information on these matters, and will doubtless prove of great value to future workers, not only from their intrinsic merit, but also for the many references to more extended works on the same subjects.

Mr. Lydekker contributes valuable articles on Fossil birds, which give the most recent account of the progress of this profoundly interesting subject. Ornithologists, as a rule, have not neglected to study the morphology of their subject from ancient as well as recent and existing forms, and in urging the necessity of pursuing this course Prof. Newton takes the opportunity, in a footnote (p. 288), of giving an extract from a speech of Huxley's, which it may not be out of place to repeat. "Palæontology," he said, "is simply the biology of the past; and a fossil animal differs only in this regard from a stuffed one, that one has been dead longer than the other, for ages instead of for days."

Prof. Roy's article on Flight sums up the recent theories on the subject, and Dr. Shufeldt's contributions on certain North American forms, concludes the list of matter additional to Prof. Newton's own work, which constitutes the great bulk of the volume, and throngs its pages with very various subjects relating to birds, which have been to him a life-long study from every point of view.

The book is a bulky one (it contains upwards of 1200 pages), yet one cannot help noticing that the exigencies of space must always have been present to the author, obliging him, as he himself declares, to compress his information into the smallest possible compass. That Prof. Newton should succeed in this difficult task no one who knows his accurate and concise methods would doubt, and that he has succeeded must be admitted by every one.

The general arrangement of the articles is, of course, an alphabetical one, but cross references are freely given, which greatly assist in finding information placed under different headings. An initial note must not be lost sight of to the effect that where a word is introduced in small capitals, without apparent necessity, further information concerning it may be sought for under that word in its alphabetical place. The index at the end will also greatly help in finding the subjects; the introduction having an index of names of its own.

Should any article seem to fal short of supplying the most recent information concerning the subject treated of, as is the case in the account of the Birds of Paradise, where no mention is made of the marvellous forms recently brought to light, it must be remembered that it has taken several years to produce the four parts in which the work was issued, and that the sheets were passed for press from the year 1889 onwards.

It is not possible in this short notice to give detailed notes on any of the many valuable articles which abound all through the pages of the book, but interest will no doubt mainly centre on the introduction, which formed article "Ornithology" in the "Encyclopædia Britannica" (published in 1885). This has already been noticed in this journal (NATURE, vol. xxxiii. p. 121), but we may say concerning it that the subject has been since then modified in some respects, and enlarged to bring it up to date. As it stands it is the most comprehensive review of the subject of ornithology extant, and in it will be found a concise summary on most of the important works on ornithology from the earliest times. These are freely criticised, sometimes with favour, sometimes with disfavour, but always, except as some will think in respect to a few recent works, in a judicial spirit.

In this introduction the complex subject of classification is fully treated of, and the various suggested schemes analysed. Prof. Newton, though confirmed in his doubts whether a really valid systematic arrangement of birds has yet been put forth, has hopes that that object may ultimately be attained. We confess that we are not so sanguine, believing that from the nature of the evidence, most of which must long ago have been irretrievably lost, the arguments in favour of many relationships must always be hypothetical, and the resulting classification always liable to modification. Still this impression of ours must not be taken to indicate want of interest on our part in morphological studies in ornithology, for we certainly believe that persistent attempts to elaborate more perfect systems of classification will increase rather than diminish interest in the subject. And this, after all, is of more value than the attainment of any goal.

Prof. Newton tells us in his preface that to his regret he was obliged to omit noticing several interesting subjects bearing upon ornithology, as well as many names of birds beyond those included. He holds out a prospect that these additions may be supplied at some future time. We add our hope that his wishes may be fulfilled, and that they may be taken in hand by the same competent authority.

O. S.

THE PRINCIPLES OF SOCIOLOGY.

The Principles of Sociology. By Herbert Spencer. Vol. iii. Pp. viii + 635. (London: Williams and Norgate, 1896.)

WITH this volume Mr. Spencer has completed his system of "Synthetic Philosophy," the work of thirty-six years. This fact gives a very special interest to his preface, where he tells with dignity and reserve of the disadvantages and disappointments under which his untiring purpose was carried through. Mr. Spencer's comprehensive survey of the sciences in the light of the conception of organic development has abundantly redeemed his promise to his subscribers. But "the first two volumes of the Principles of Sociology have expanded into three, and the third, which if written would now be the fourth, remains unwritten. It was to have treated of Progress." Mr. Spencer has been too much of a pioneer, perhaps, to hope to say the last word of evolutionist science on progress. But if his pleasure in his emancipation, to which he refers as his dominant emotion on the completion of his task, be not too great, we may venture to hope for a further contribution on the subject from the master's pen.

Of the present volume the first part has already seen the light in book form, under the title "Ecclesiastical Institutions." It traces the origin of the religious idea to the apparition of dead ancestors in dreams. "Gods arise by apotheosis." Whatever may be said as to the derivation of certain forms of fetishism and of the animal cults connected with totemism from ancestor worship, it is unlikely that the worship of nature-powers was at its source "but an aberrant form of ghost-worship," as Mr. Spencer holds. But at any rate, in the need to maintain right relations with ghostly powers, there arose the first professions—those of priest and medicine-man. The latter is essentially an exorcist, and his functions are gradually usurped upon by the propitiator of the beneficent spirits of the family, and specially of the chief's family. So that it is from the priest, as he becomes the comparatively leisured and sole repository of knowledge, that the professions draw their origin.

The second section, dealing with Professional Institutions, has already appeared in the shape of review-articles. It finds all those modes of the enrichment and expansion of life, which we call the professions, in germ in the priestly office. Not only teacher, architect, and musician, but actor and lawyer, surgeon and physician, man of science and philosopher spring up in the service and under the shadow of religion. Even where medical appliances were natural, the ideas which accompanied them were supernatural, so that the priest rather than the medicine-man is the source of modern medicine. And notwithstanding much specialisation—witness the Indian rhinoplast—and the empirical training of slave-doctors, the complete emancipation of surgery and medicine is quite modern. It was only the prohibition of clerical shedding of blood that freed the surgeon; it was because their medical duties too much engrossed the time of the clergy, that specialist physicians arose, whom in time a papal bull permitted to marry. Under Henry VIII. a licence to practise in London issued from bishop or dean, "assisted by the faculty." As late as 1858, a medical diploma was granted by his Grace of Canterbury.

To interpret the sacred writings we need grammar. To determine the construction and orientation of altars and shrines, and to fix the seasons of sacrifice, we must have geometry and astronomy. It is the pontiff alone who has the secret of the arch. Hence even the concrete studies of the men of science are priestly; while in Greece alone of the ancient world were these and the abstract speculations of the philosopher emancipated, because "before there was time for an indigenous development of science and philosophy out of priestly culture, there was an intrusion of that science and philosophy which priestly culture had developed elsewhere," and the political incoherence of Greek states prevented the dominance of a hierarchy. Equally ingenious is the treatment of other apparent exceptions, popular music side by side with sacred music in the mediæval world, and the Roman contempt for the slave-actor.

The closing part of the work deals with Industrial Institutions, and is wholly new. An account of the division of labour, which owes nothing to Adam Smith, a history of the origin of exchange, which lays stress on the pre-barter stage, and which draws from the experiences of Cameron a novel illustration of the necessity for the evolution of money, and from the observations of Coote a new example of the qualities found necessary for good money, are followed by a sketch of the development from status to contract, in which the control of family or of chief or, here only incidentally, of priest gives way to guilds originally based on kinship, to free labour and to trades unions, or in which the condition of slavery passes through serfdom to freedom of contract. In this part of Mr. Spencer's work, brilliant though it is, the need that anthropology still has of an adequate method is apparent.

With free labour and its efforts to establish new groupings we pass to the treatment, not altogether convincing from the economist's point of view, of trades unions, co-operation, profit-sharing, and socialism. Of the first, Mr. Spencer is the candid and not hostile critic, though he fears a recrudescence of militant policy, and observes that the guilds, as contrasted with the unions, enforced a standard of work. As regards the rest, Mr. Spencer, feeling sure that all the victories of civilisation have been won by an increase of liberty, is inclined to regard redintegration as a step backward. Though the consideration of the effects of machinery on the labourer, who under the coercion of circumstances as producer "loses heavily—perhaps more heavily than he gains" as consumer, gives pause to Mr. Spencer's optimism, he concludes, as he began "nearly fifty years ago," with the conviction that "the ultimate man will be one whose private requirements coincide with public ones; he will be that manner of man who, in spontaneously fulfilling his own nature, incidentally performs the functions of a social unit, and yet is only enabled so to fulfil his own nature by all others doing the like.'

H. W. B.

OUR BOOK SHELF.

Short Studies in Physical Science. By Vaughan Cornish, M.Sc. Pp. 230. (London: Sampson Low, Marston, and Co., Ltd., 1897.)

New Thoughts on Current Subjects. By the Rev. J. A. Dewe. Pp. 230. (London: Elliot Stock, 1897.)

IT may be doubted whether the republication, without additions, of articles and reviews contributed to ephemeral literature serves any useful purpose. Many, if not most, of the articles in Mr. Vaughan Cornish's book are reprints of contributions to *Knowledge* and *The Speaker*; but though they are good examples of what popular scientific articles should be, the fact that they deal to a large extent with current topics, necessarily from the point of view of information available at the time when they were written, and have not been brought up to date, makes their republication undesirable. An article on argon, for instance, written in February 1895 (February 1894, on p. 75, is evidently a misprint), does not contain a satisfactory account of argon as we now know it; and a similar objection may be raised to the articles on helium (written June 1895), on the Röntgen rays (written March 1896), and on Moissan's synthesis of diamonds (written in March 1894). The reprinting of a popular review of a popular book on astronomy is still more open to objection.

The papers included in Mr. Cornish's book deal with subjects in the fields of mineralogy, chemistry and physics. They contain a certain amount of interesting information, and possess the merit of accuracy; so that they may be read with pleasure and profit by the general reader who does not mind being a little behind the scientific times.

The Rev. J. A. Dewe's volume is wider in scope than that of Mr. Cornish; its subjects are social and philosophical as well as scientific. The five essays in the scientific section deal with sea salts and carbonates, the nature of heat, the nature of electricity, stellar and absolute space, and the science and harmony of smell; while among the subjects of the philosophical chapters are free will *versus* heredity and environment, and the dogmatic and scientific accounts of the creation of man. The book has a leaning to metaphysics, but many common experiments are clearly described, and sound conclusions are arrived at from simple arguments. We commend the book especially to men of the author's profession, believing that many of them would acquire breadth of thought by the perusal of it. For ourselves, we are glad to live in the days when a clergyman can calmly discuss facts as to similarity that exist between the physical structure of the human body and that of the monkey, and can say "they lead irresistibly to the conclusion that, as far as the physical part of man is concerned, no exception was made in the laws of the material universe, but that the body of the one slowly developed into the body of the other."

Vorlesungen über Bildung und Spaltung von Doppelsalzen. By Prof. J. H. van 't Hoff. German, by Dr. Theodor Paul. Pp. iv + 95. (Leipzig: Wilhelm Engelmann, 1897.)

THE present work is a reproduction of the substance of courses of lectures delivered in Amsterdam and Berlin in the years 1894 to 1896. It will be very welcome to the larger public to which these lectures are thus made accessible. They deal almost exclusively with the researches of the author and his pupils on the formation and decomposition of double salts. The original form of the lectures has not been retained, the subject-matter being treated under three heads. Under the first, the behaviour of a sparingly soluble double salt formed by the union of two binary salts, with or without water of crystallisation, is investigated from the standpoint of the author's theory of dilute solutions and the theory o electrolytic dissociation. The temperatures and pressures at which a double salt can exist, its decomposition by a solvent, and the influence of the presence of one or other of its components on its stability are theoretically investigated.

The second part contains a description of the experimental methods used in the study of the decomposition of double salts, in determining transition temperatures, vapour pressures of the salts and their solutions, solubilities, and other quantities of importance in investigations of this kind. The methods are all original, and this section should be of great service to workers in this field of research. In the third part, the behaviour of bipotassium copper chloride, hexahydrated magnesium potassium sulphate, sodium ammonium and sodium potassium racemates, and the right and left-handed Rochelle salts are minutely described, and shown to be entirely concordant with that theoretically predicted.

These lectures, thus, carry the investigation of the double salts, described in the "Studies in Chemical Dynamics," a step further. In the latter book the temperature at which the complete change of a double salt into its components occurs was fully studied; here the other conditions which affect the existence of double salts are taken into account, and the whole of the region in which such a salt is capable of existence investigated. The book is one with which all who are interested in inorganic and physical chemistry should be acquainted.

Practical Electrical Measurements. By Ellis H. Crapper, A.I.E.E. Pp. xii + 125. (London: Whittaker and Co., 1897.)

THE experiments described in this book should be very serviceable in imparting a real knowledge of the fundamental principles of magnetism and electricity. Only by numerous measurements can a student obtain familiarity with measuring instruments and the principles underlying their construction and use. Such work recorded in a systematic and intelligent manner is the best training a student can have to qualify him for the testing-room of electric light and cable stations. The experiments described are almost entirely quantitative, and they include all the usual magnetic and electrical measurements made in physical laboratories. The book thus not only furnishes a course in electrical testing, but may also be profitably used by advanced students in Organised Science Schools and Technical Schools.

Notes of Lessons on Elementary Botany. Prepared to meet the requirements of the Code of the Committee of Council on Education; together with an Appendix, intended as an introduction to a British Flora. By W. Bland. (London and Derby: Bemrose and Sons, Ltd., 1897.)

THIS little book is not altogether devoid of use; but the author has often sacrificed clearness at the shrine of ambition, in endeavouring to compress about three times too much matter into his pages. As it stands at present, it is fitted to take a place amongst the cram-books, and, like them, is often obscure, or even worse, from the point of view of accuracy. We should pity the child who endeavoured to get on without a large addition of oral help. Many of the figures might well be improved.

Dr. Nansen: the Man and his Work. By Frederick Dolman. Pp. 108. (London: Society for Promoting Christian Knowledge, 1897.)

THIS is a very simple story of some of Dr. Nansen's characteristics, schemes, and successes. It contains little, if any, new information.

LETTERS TO THE EDITOR.

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Early Arrival of the Swift.

A FEW minutes before six o'clock in the afternoon of March 26, my brother, Sir Edward Newton, saw, from the cliff near the high lighthouse at Lowestoft, what, at the first glance, looked like a Swallow, flying over the trees in the garden of the house known to many as that occupied more than thirty years ago by the late Dr. Whewell. As the bird turned and gave us a better view of it, we perceived it to be a Swift. Crossing the foot-bridge and getting to the edge of the Park overlooking the garden, we watched it pass backwards and forwards for about a couple of minutes, when it flew away to the northward, and, though we waited for some little while, it did not reappear. I may add that we were favourably placed as regards light, the sun being behind us. I do not recollect any record of the occurrence of the Swift in England so early as this by some weeks, and it would be interesting to know if the bird should have been observed elsewhere. ALFRED NEWTON.

March 27.

Red Dust of Doubtful Origin.

ON Tuesday morning, March 22, I noticed on the glass of our greenhouses, and on many of the shrubs, a sort of red dust. On making inquiries I found the same thing existed about two miles off, due west. I collected some, and, by the kindness of one of the directors of Messrs. Brunner, Mond, and Co., it was examined in the laboratory connected with their works. To-day I got the report, which is as follows:—

"The dust, under high magnification, shows minute fragments of clayey matter mixed with quartz. Organic matter such as pollen grains are absent. The particles are about 0·0001 millimetres in diameter, many of them less.

"The chemical examination shows clay mixed with a little carbonate of lime and a fair amount of fine sand. The reddish colour is due to oxide of iron."

We are surrounded by grass; the soil is a clayey loam without oxide of iron or quartz.

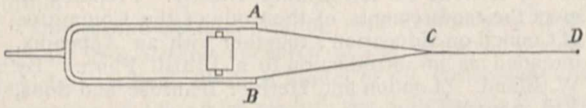
Could any of your readers suggest where the dust can have come from? J. M. YATES.

Davenham, Cheshire.

Experiment on Interference.

I HAVE successfully performed the following experiment on interference:—

To the prongs of an electrically-driven fork are fastened the ends A and B of an elastic string; at the middle point, C, of this string another string, C D, is fastened. D is held in a clip, and the whole stretched. By properly adjusting the lengths and



tension, A C and B C will vibrate in unison, while C D remains motionless; but if A C or B C be damped, C D immediately vibrates.

This is a very pretty experiment when projected, and by flashing the light on it is easily demonstrated that A C and B C are always in opposite phases. JOHN WYLIE.

101 University-street, Belfast, March 8.

The Additional Colouring Matter of "Fucus vesiculosus."

I DO not know whether the following is likely to be of any interest to your readers.

Having prepared a solution of the brown additional colouring matter of the common Bladder wrack, I placed it in the line of a beam of sunlight that had passed through a prism, with the result that the violet indigo and blue rays were entirely intercepted, whilst the yellow orange and red rays were practically unaffected. I repeated this test with vessels that, owing to their flatter form, presented varying quantities of the solution, and in one in which the rays had only to pass through about a quarter of an inch of the liquid the green rays were slightly visible, but neither the blue nor the violet. To make sure that the vessels had nothing to do with the result, I filled them with plain water and passed the beam through them.

Is it justifiable to conclude from this that the action of this additional colouring matter is to protect the chlorophyll from the relative increase of the blue rays, and *not* to heighten the effect, save indirectly, of the others?

Could any of your readers refer me to any papers upon the chemical nature of this additional colouring matter, &c.? CLARENCE WATERER.

Ingleside, Northdown Road, Margate, March 8.

Chinese Yeast.

IN answer to Mr. C. E. Stromeyer's query in NATURE, March 18, p. 463.

An account of *Lévure chinoise*, with details on the manner in which it is prepared, and on the moulds, yeasts, and bacteria it contains, is given by Calmette in the *Annales de l'Inst. Pasteur*, t. vi., 1892, p. 604. A lengthy review of Calmette's paper appeared in *Centralblatt für Bakteriologie*, vol. xiii., 1893, p. 273. ITALO GIGLIOLI.

Agricult. Chem. Laboratory, Portici, near Naples.

The Electric Eel.

ON a recent expedition to the N.W. district of British Guiana, I was able to secure a specimen of the electric eel, which I believe to be the largest on record. The fish measured 7 feet 2 inches in length. It was caught with hook and line in a very shallow and unfrequented branch of the Waini River. The skin is now in the local museum. J. J. QUELCH.

British Guiana Museum, March 3.

The Utility of Specific Characters.

I HAVE followed the discussion on this subject with great interest; and though I am at such a distance that my thoughts may come a little late, I wish to call attention to a few points. In NATURE for October 22, 1896, p. 605, mention is made of a discussion on Neo-Lamarckism at the British Association. In opening the discussion, Prof. Lloyd Morgan referred to the importance of noting the bearing of certain cases that may be considered as crucial, or as nearly crucial as any that we are at present able to obtain, on the process by which specific instincts are built up. As illustrating this class of cases, he refers to the drinking instinct in newly-hatched chickens, where the instinctive response begins at the point where the teaching of the parent bird would naturally be inadequate.

The question I wish to raise is, whether such observations as this can do more than justify the conclusion that life-saving instincts are strengthened and established by natural selection. Are they sufficient to show that all permanently inheritable specific characters are wholly due to natural selection, or even that natural selection is always one of the factors by which any and every permanent character has been built up? It seems to me that there are large classes of facts, some of which may be found in almost every species we examine, which throw doubt upon there being any such inseparable connection between natural selection and the inheritance of characters.

The majority of the human species inherit right-handedness. Does this prove that right-handedness is better for the race than left-handedness? The shells of most molluscs are coiled in a way that is called dextral; but some groups of species are as constantly sinistral as most groups are dextral; and of the dextral groups there are certain species that are persistently sinistral; others that are nearly equally divided between dextral and sinistral forms. Is it necessary to believe that for each species that is usually either dextral or sinistral, there is some vital necessity that would exterminate, or even diminish, the species if the character was reversed? A similar class of cases is found amongst the different species of flat-fish. One species persistently lies on the right side, another on the left, and I think it is Mr. Cunningham who has told the readers of NATURE that there are some species in which both forms may occur. In twining plants similar persistence is observed in the direction in which the vine encompasses the support. In each of these classes of cases I am unable to conceive of any advantage gained by the species that would not be equally gained, if the character under discussion was reversed. If the adaptation to the environment of a flat-fish that now lies upon the right side would be equally good in case all the individuals of the species lay upon the left side, then (if I rightly understand the meaning of the terms), natural selection cannot be the cause of its lying on the right side rather than the left, neither can this character of the species be considered a useful character, though it is persistently inherited.

Standing near me is a flower-pot, in which are several stalks of the common calla (I believe the botanical name is *Richardia æthiopica*) in bloom; and a little inspection shows that each spathe and leaf-bud is twisted in the same way. If the leaf is held with the point up, and the upper surface toward you, the half of the leaf on your left is the part that formed the inside of the leaf-bud, and the margin of the leaf on your right is the part that formed the outside of the leaf-bud This character is quite persistent in the specimens of this species found in this city, though I am told that a leaf twisted in the opposite way sometimes appears; while in the distinct species, popularly called the black calla, I believe the character is reversed. Now, does this persistence prove that the character in question is essential to the welfare of the species? Are we justified in assuming that natural selection is the cause of the persistence of such characteristics? Can any one throw light on the subject that will make it easier to believe that the adaptation of the species would be in the least impaired if all the leaves and spathes were twisted in the reverse way?

The usual method of meeting the natural inference from such cases is based on a double assumption, the first part of which is that natural selection is the only intelligible explanation of the modification of species or the persistence of character that has ever been given, and that, if in any case we abandon this explanation, it is equivalent to abandoning all explanations; the second part of the assumption being that it is simply our ignorance of the facts that prevents us from recognising the life-preserving results that are gained by the characteristic in question. This assumption ignores both the fact that species presenting character of the kind referred to are found on every side, indeed that almost every species that fails to maintain complete symmetry of form is an example, and the fact that Darwin himself pointed out another principle beside natural selection producing persistent characters. This principle of sexual selection he carefully distinguished from natural selection, showing that the results produced by it could never be produced by natural selection, and even maintaining that "It is not surprising that a slightly injurious character should have been thus acquired" ("The Descent of Man," 2nd ed., p. 601).

For my part, I do not think much progress can be made in discovering where natural selection is the chief agent, and where it is not the chief agent, till we have carefully defined what we mean by utility and natural selection, and then adhere to our definitions. In my papers on "Divergent Evolution through Cumulative Segregation" and "Intensive Segregation" (the former published in the *Linnean Society's Journ.—Zoology*, vol. xx.; the latter in the same, vol. xxiii.), I have endeavoured to show that there must be several principles somewhat similar to sexual selection, which I have grouped with it under the names reflexive segregation and reflexive selection. In the former of these papers, pp. 212-214, I have pointed out that "Of freely crossing forms of any species it is only those that are most successful that are perpetuated; while of forms that are neither competing nor crossing, every kind is perpetuated that is not fatally deficient in its adaptations"; and this will be the case whether the forms are held apart by reflexive, or environal segregation.

Let us consider the case of two allied species occupying the same area, and differing from each other in what Dr. Wallace has so appropriately called their recognition marks, and in the segregating sexual and social instincts correlated with these marks. If investigation justifies the belief that an early stage of divergence, due, perhaps, to local segregation, resulted not only in sexual and social segregation, but also in what I have called divergent social selection (or what Dr. Wallace prefers to call selective association), then we are warranted in the belief that this segregative and selective principle was sufficient to perpetuate and intensify the new character, although the section of the species possessing the new character had not migrated into any new environment, and had not been exposed to any change in the old environment, and although it had not gained any new adaptation to the common environment of the two sections, and, therefore, while both sections of the species were equally subject to identical forms of natural selection.

Now, seeing that the individuals of the segregated sections are able to find and keep company with associates, and in the season to pair with suitable mates, as affectually, but no more effectually, than before they were segregated, what shall we say of the usefulness of the distinctive characters that produce the segregation? It is plain that these divergent characters are in constant use; but does that prove that the divergence is a useful divergence? Is it not possible that there should be a difference in use, which is not a useful difference? and if nothing has been gained by the difference either in maintaining the conditions of individual life, or in propagating the species, how can we call it a useful difference? And how can we attribute the divergence to natural selection, seeing natural selection is the superior maintenance and propagation of those better adapted to maintain life under the conditions surrounding the species?

I maintain that this reflexive segregation through the sexual and social instincts of the divergent sections of the species, is the first in a series of divergent characters which may become a great advantage to both sections of the species, by enabling them to become adapted to different kinds of resources, requiring incompatible adaptations; but it cannot be claimed that the usefulness to which this segregative character may attain in the future, or may have already attained, was the cause of the divergence which was steadily perpetuated, being intensified by sexual and social selection, and so completed while as yet this character was of no service to the species. The segregative character is preserved by its segregativeness, though at the time it arises, and for many subsequent generations, it may not be of any advantage to its possessors. In most such cases, I believe, the initial divergence is gained by a local variety, in some measure protected by local segregation; but having gained a character which secures segregation, even when commingled with the other section of the original species, it is no longer liable to be swamped by crossing. It seems to me that such cases are examples of divergence, produced by segregate breeding, brought about by sexual and social segregation, reinforced and strengthened by sexual and social selection, and not by diversity in the action of natural selection.

Another fundamental distinction, that needs to be kept in mind, is that diversity in the action of natural selection on segregated sections of a species may be due to three classes of causes, which are the real causes of the divergence, which results in the production of different species.

(1) Different life-supporting and life-endangering conditions existing in the different districts in which the different sections of the species are distributed.

(2) Different methods of using resources and escaping dangers, adopted by the different sections, though occupying the same district.

(3) Different methods of using resources, and escaping dangers, adopted by the different sections of the species occupying isolated districts, whose resources and dangers are alike.

If the members of the original species are brought under the influence of the first class of causes, it is due to diversity in the environments to which migration introduces them; if under the second class, it is due to diversity in the action of life-preserving habits, while competing with each other: if under the third class, it is due to diversity in this second respect, while not competing with each other.

Now, in some of the cases in the second class and in all those of the third class, it is impossible that the differences should be useful. This is most easily shown as regards the third class; for if in any case a new character attained by one of the sections is an advantage, then the same character would be an advantage for each of the other sections, exposed to the same conditions in other regions, and, therefore, there is no advantage in the difference.

If my thought is correct, some of the differences produced by diversity in the action of the several forms of reflexive segregation and selection, and all those produced by diversity in the action of natural selection, when that diversity is due to different habits that are not necessitated by any difference in the environment, are non-useful differences. Therefore, beside the principle of "correlated variation" referred to by Prof. Lankester (Nature, vol. liv. pp. 245, 365), we have other explanations of certain kinds of specific characters that are not useful; but the class of characters, of which right-handedness and left-handedness are examples, seem to lie beyond the reach of these explanations, and perhaps beyond the reach of the explanation suggested by Prof. Lankester.

15 Concession, Osaka, Japan. John T. Gulick.

COCCOSPHERES AND RHABDOSPHERES.

THERE have been few more enduring puzzles in natural history than the nature of the Coccoliths, described by the late Mr. Huxley from Captain Dayman's deep-sea soundings in the North Atlantic in H.M.S. *Cyclops* in the summer of 1857. Dr. G. C. Wallich, who was on board H.M.S. *Bulldog*, engaged in a preparatory survey of the route for a telegraph cable about the same date, observed the aggregation of the Coccoliths into spheres, to which he gave the name of Coccospheres. He also pointed out the identity of the Coccoliths with bodies observed in chalk by Mr. Sorby. Mr. Huxley associated them with that unfortunate organism *Bathybius*. "I am led to believe that they are not independent organisms, but that they stand in the same relation to the protoplasm of *Bathybius* as the spicula of Sponges or of *Radiolaria* do to the soft part of those animals" (*Quart. Journ. Micr. Sci.*, vol. viii. N.S. p. 210, 1868). Prof. Haeckel, who received some ooze dredged by Wyville Thomson and Carpenter (*Porcupine* Exped.), put a like interpretation on the phenomena, and published in the *Jenaische Zeitschrift*, vol. v., 1870, a detailed account of the matter with illustrations. *Bathybius* is dead, but one cannot leave it without the reflection that there are few naturalists, the young and expert included, but would have given similar explanation of the appearances. The *Challenger* Expedition next entered the field, and discovered Coccospheres and Rhabdospheres on the surface of the ocean, living free in the water, entangled in the protoplasmic matter of *Foraminifera* and *Radiolaria*, and in the stomachs of *Crustacea* and *Salpæ*. The Rhabdospheres are known only from the tropics, and the Coccospheres, though tropical as well, yet find their finest development in temperate seas. "There is considerable variety both in the form and size of Coccospheres and Rhabdospheres, some varieties having the component parts (Coccoliths and Rhabdoliths) much more compactly united into a sphere than others. The interior of the spheres is perfectly clear when examined fresh from the surface, and becomes coloured brown with iodine solution, but with iodine and sulphuric acid no blue colour was observed. They were never observed to colour with carmine solution. When the calcareous parts are removed by dilute acids, a small gelatinous sphere remains, in the outer layer of which the Coccoliths and Rhabdoliths were embedded" (*Challenger* Reports, "Narrative," vol. i. p. 939). In the Report on the Deep-Sea Deposits, Dr. John Murray treats them as pelagic calcareous algæ (p. 257), and one of us has been criticised with some severity for adopting this view in an "Introduction to the Study of Seaweeds." The Hensen Plankton Expedition, probably through using silk nets of too coarse a texture, failed altogether to find Coccospheres or Rhabdospheres, and Dr. Schütt, the botanist of that expedition ("Pflanzenleben der Hochsee," p. 44), casts doubt on their very existence as organisms, and in any case will have none of them in the vegetable kingdom. Many other naturalists, wise and eminent, British and foreign, have shared, and do share, the opinion of Schütt.

What the Hensen Expedition failed to discover has been effected, however, by quite simple means. A few years ago, Dr. John Murray, while crossing the North Atlantic, obtained the Coccospheres again by simply pumping sea-water through a very fine silk bag. He observed them carefully, and noted their contents to be yellowish, of much the same colour, he now informs us, as the diatoms. While using such a bag last year in diatom work on the *Garland*, it occurred to one of us that Coccospheres and Rhabdospheres might be obtained by this method in the hands of some enterprising mariner. Captain Haultain Milner, of the Royal Mail steamship *Para*, to whom natural history owes many debts, readily consented to put the method to the proof; and, after rehearsing his part in the laboratory of the Botanical Department of the British Museum, sailed last January, equipped with a fine silk bag, tubes with non-acid fixing and preservative fluids, funnels, &c., for the port of Barbados. He was instructed that it would be sufficient to pump for a short time daily with the ordinary deck-hose (intake pipe, three fathoms deep) through the silk bag, and to transfer the residuum to the tubes containing the fixing and preservative fluids. Captain Milner has carried this out, pumping daily in the region agreed upon. It is interesting to observe that Coccospheres abound in the first day's capture (lat. 41·30 N. long. 19·40 W.)—the method succeeded in his hands in the most deadly way—and he subsequently obtained, in the tropical part of his voyage, both forms of Rhabdospheres figured by the *Challenger* Expedition. He got, in fact, not only what the German expedition failed to find any trace of, but all the three forms figured in the *Challenger* Report.

In Fig. 1, *a* and *b*, there are copied from the *Challenger* "Narrative" a Rhabdosphere and a Coccosphere. The Coccosphere figured was obtained from the bottom, and

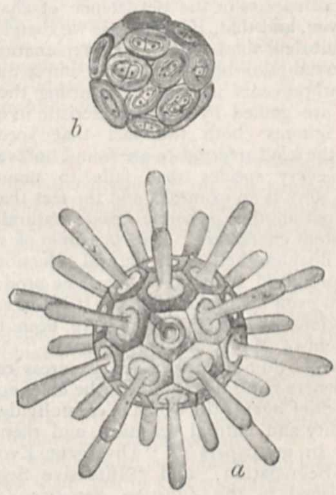


Fig. 1.—*a*, Rhabdosphere × 250; *b*, Coccosphere × 500 (after *Challenger* Report).

shows a disorganised condition. The plates composing the shell of the Rhabdosphere are represented as fitting into each other with geometrical regularity. In the specimens we have seen and been able to examine, not on the heaving deck of a ship at sea, but with the resources and apparatus of modern research, the structure of the shell appears in each case different from that given in the *Challenger* Report. Fig. 2, A, represents a Coccosphere, as we see it, and a very minute and elusive microscopic object it is, under a 1/12th aprochromatic objective. The calcareous scales (or Coccoliths) overlap each other, and constitute not only an excellent defensive armour, but from their arrangement admit of the growth of the organism, which is not thus limited by its calcareous coat, as the diatoms are by their siliceous shells. Each Coccolith is attached to the cell by a button-like projection on its inner surface. A figure nearly resembling ours occurs in *Challenger* Reports, "Deep-Sea Deposits," plate xi. Fig. 3. In the Rhabdosphere, with projecting rods shown in Fig. 2, B, C, the plates (Rhabdoliths) do not fit into each other in the manner figured in the *Challenger* Report, but their bases or bed-plates are embedded on the surface of the cell, each by itself without contact. This may be, on the one hand, a temporary condition due to turgidity in the specimens observed, or the plates we see may be themselves connected with each other by a finer incrustation. Fig. 2, D, E, represents another Rhabdosphere with trumpet-shaped projections; D, being an optical section, and E a surface view. We have hitherto been unable, partly from the rarity of the objects, to define microscopically the bed-plates to which the trumpets are attached, if such exist. The wall of the cell, probably composed of such plates, presents, in optical section, indications of their existence. At 2 F there is shown the outer end of one of the trumpets.

As to the cell-contents, we have been unable to discover more than the existence of a granular material inside the Coccospheres and Rhabdospheres of both types—a granular material which, under ordinary circumstances, no one would hesitate to call protoplasm. On decalcifying the Coccospheres with very dilute acid, there is left a small gelatinous-looking body which slowly swells up. There is no trace of colouring matter in our

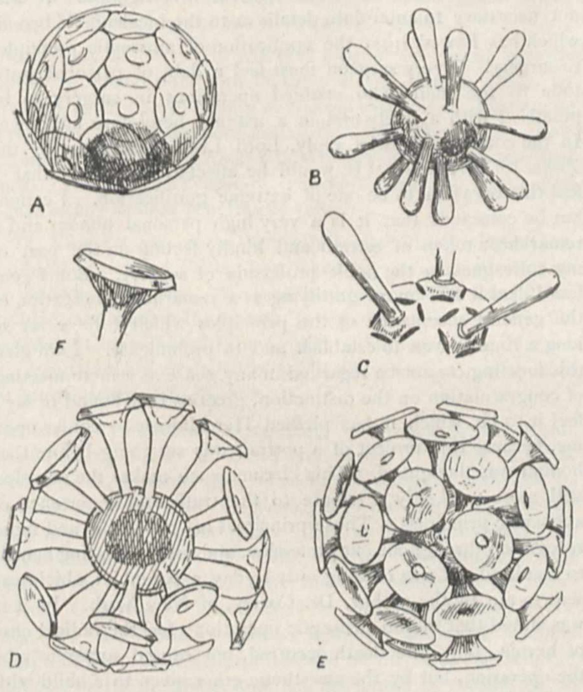


FIG. 2.—A, Coccosphere × 1300; B, Rhabdosphere × 900; C, portion of the same × 1300; D, Rhabdosphere of another type, in optical section, × 1900; E, the same, in surface view, × 1900; F, end of trumpet-shaped projection × 2500.

specimens, and Dr. John Murray, who has seen them, tells us this is frequently the case with specimens examined immediately after capture. They all came from three fathoms, and not from the surface itself. It may be that the living, coloured cell is most abundant at the surface itself, and that our specimens are those which have already begun to sink.

The importance of the part probably played by Coccospheres and Rhabdospheres in the economy of marine life entitles them to a large claim on our interest. They abound in regions of the ocean, out in blue water, and far away from coastal waters, where diatoms and *Peridinieæ* are comparatively scarce; and here their occurrence is in such plenty that their shells on sinking to the bottom constitute nearly 20 per cent. of some deep-sea deposits. Of a like geological history with the diatoms, first appearing in the ancient Cretaceous seas, Coccospheres and Rhabdospheres probably share with them, with the *Peridinieæ* and with the pelagic *Oscillatorieæ*, the *rôle* of food providers to the animal life of the ocean.

GEORGE MURRAY.
V. H. BLACKMAN.

M. ANTOINE THOMSON D'ABBADIE.

THE name of Abbadie has been long and honourably known in the history of science in France. Three brothers of the name have all played a worthy part in geography, in physics, or in ethnography, but the best known is the subject of this short note. The family, which is of ancient descent, appears to have temporarily left their home in the South of France at the time of the political troubles at the end of the last century, and to have settled in Ireland, where, in 1810, Antoine d'Abaddie was born. On the restoration of the Bourbon dynasty, his father returned to France, and it is entirely as a French man of science that Abbadie has won his reputation.

At a time when travelling into and opening-up of the less known and inaccessible parts was not so common as it has proved since, M. d'Abbadie's tastes marked him out as an early explorer. His first journey was made to the Brazils, in 1835, under the auspices of the French Academy; and on his return from South America he started, in 1837, in company with his brother Michel, for Ethiopia, as it was then known. In Abyssinia and in Central Africa the two brothers made a prolonged stay, returning to France in 1848, and their ethnographic and linguistic studies had much interest at the time. The principal results of the voyage were communicated to the French Geographical Society, and were published under the title "Notes sur le haut fleuve Blanc," 1849. The early date at which this exploration was made is of equal importance with the results gathered. If the accuracy of some of these results has been questioned, they at least indicated the necessity for further investigation. The journeys of Richardson and Barth were some years later. Burton and Speke began their travels in 1853. Livingstone returned to this country with his first results in 1856; so that M. d'Abbadie is certainly entitled to be remembered as a pioneer in African research.

Though M. d'Abbadie gave much attention to linguistic work, he applied himself to astronomical pursuits with some eagerness. In 1857, he visited Norway, with the view of observing the total solar eclipse of that year. The point to which he directed his attention was the examination of the light of the solar prominences for the detection of polarisation. With the view of still further satisfying himself on this point, he took advantage of the eclipse of 1860 to go to Spain, where, accompanied by M. Petit, of the Toulouse Observatory, he made some further observations at Briviesca. Observing with a quartz plate and double-image prism of small angle of separation, no trace of polarisation was detected. The account is given in the *Ast. Nach.*, No. 1290. Later, in 1882, and notwithstanding his advanced age, M. d'Abbadie took charge of one of the French stations selected for the observation of the transit of Venus. The position occupied was at Port au Prince, in Saint Domingo, a station well adapted for observing the effects of both retarded ingress and accelerated egress. The observations were successful.

M. d'Abbadie was elected Chevalier of the Legion of Honour in 1850, and became Member of the Academy in 1867. He has occupied a seat at the Board of Longitude since 1878. He was elected a Fellow of the Royal Astronomical Society so recently as 1895, his interest in astronomy having probably quickened in the later years of his life. This is shown by the disposition of his property, which is handed over to the Academy of Sciences on the condition that the Society publishes a catalogue of half a million of stars within the next fifty years.

MR. W. W. RUNDELL.

A LARGE circle connected with the British Mercantile Marine, besides many others interested in magnetic science, will regret to learn that W. W. Rundell, so long associated with Liverpool and its nautical affairs, died a few weeks ago at the advanced age of eighty-one.

We first hear of Rundell in 1845, when he became Secretary of the Cornwall Polytechnic Society, a post which he held until 1855, when he was appointed Secretary of the Liverpool Compass Committee.

It will be remembered that this Committee sat during the years 1855-57, and by 1860 had made three reports to the Board of Trade on the magnetism of a majority of the iron ships leaving the port of Liverpool, the necessary compensations to be made for the resulting deviations of ship's compasses, and the proper equipment and placing of such compasses. This was a work of the highest importance at a time when iron ships were rapidly increasing in numbers, and much danger existed in their navigation from the ignorance which prevailed on the subject.

To Rundell was entrusted the details of the experimental investigations, and the keeping the necessary records of proceedings, an onerous post which he occupied with great zeal and marked perception in reducing and coordinating a mass of results, often of an apparently contradictory nature.

In the spring of 1857 the Liverpool Compass Committee was dissolved, and Rundell was appointed Secretary of the Underwriters' Association of Liverpool; but for the succeeding three and a half years he worked during his leisure hours at the preparation of the valuable third Report of the Liverpool Compass Committee, and this altogether as an honorary task.

Although in many questions relating to the magnetism of ships he was ready to work cordially with Smith and Evans, who were then carrying on an important work connected with the magnetism of ships in the Royal Navy, Rundell had one important difference of opinion with them—as regards the mechanical correction of compasses.

Smith and Evans objected strongly to compensating the standard compasses of ships by magnets and soft iron, advocating reliance upon deviation tables for correcting the compass courses steered. Rundell, supported by his friend Towson, insisted on the complete compensation of compass errors, so strongly advocated by Airy the inventor of the methods of doing so. The Mercantile Navy followed him, and he has lived to see the Royal Navy more bent on rigorous compensation than the Mercantile.

In 1862 he contributed an excellent paper on compass equipment in iron ships to the Institution of Naval Architects, followed by another on the same subject in 1866. This latter paper contained a vigorous protest against Government supervision of merchant vessels as regards their compasses, and especially to placing the regulation of their equipment under the control of the Admiralty Compass Department, as proposed by the Royal Society to the Board of Trade, but declined by the Board.

Rundell, however, did not content himself with a protest, but made some excellent propositions, which for the most part have been adopted by the Board of Trade.

Zealous and painstaking in whatever he undertook, firm in any position which his well-balanced mind caused him to take up, Rundell was of a kindly disposition and surrounded by friends, many of whom he has survived. He has left an indelible mark on the service to the benefit of which so many years of his life were devoted.

E. W. C.

NOTES

ON Monday last, Lord Lister's professional brethren gave a visible sign of their high regard for him, and their appreciation of his work, by presenting his portrait, executed by Mr. W. W. Ouless, R.A., to the Royal College of Surgeons. In making the presentation on behalf of the subscribers, Mr. Davies Colley remarked that before long he hoped that those thousands who owed life and health to Lord Lister's discoveries would show their gratitude by founding some institution, or raising some great monument in his honour. There was, however, a special fitness in having a portrait painted of one who had done so much to advance the science of surgery, and placing the picture side by side with the portraits of John Hunter, Astley Cooper, and the other great surgeons who had done similar work. Sir William MacCormac, President of the College, in accepting the portrait, pointed out that a revelation in surgery, one of the most beneficent which has happened in our time, has been the result of Lister's patient investigation. It was not necessary to enter into details as to the incalculable benefit which has flowed from the application of antiseptic principles to surgery. Every surgeon must feel a debt of personal gratitude to the man who enabled operations in surgery to be practised with a safety and in a manner heretofore unknown. In the course of a brief reply, Lord Lister is reported by the *Times* to have said: "It would be affectation to deny that I feel this occasion to be one of extreme gratification. I cannot but be conscious that it is a very high personal honour and a remarkable token of esteem and kindly feeling on the part of my colleagues in the noble profession of surgery. But I confess I feel it still more gratifying as a remarkable indication of the general acceptance of the principles which I have for so long a time striven to establish and to promulgate. I am glad this meeting cannot be regarded in any sense as a mere meeting of congratulation on the distinction, great as I am bound to say I feel it to be, which it has pleased Her Majesty to confer upon me, because this project of a portrait was set going before that honour was thought of. This circumstance makes the occasion still more markedly a tribute to the truth and importance of antiseptic principles. Those principles are now more and more recognised throughout our profession, and with increasing benefit to mankind. I was reading only to-day a pamphlet which was sent to me by the author, Dr. Coaley, of New York. In it it was stated that in 360 antiseptic operations for the radical cure of hernia, only one death occurred, not caused apparently by the operation, but by the anæsthetic ether given to a child with weak lungs. An achievement like that is enough to cause gladness in the heart of any man who loves his fellow-men. And yet I cannot help remarking that such results could not have been obtained by the mere recognition of the truth or importance of antiseptic principles. Such success implied that the operator was not only convinced of the truth of those principles, but also that he vigilantly maintained throughout his operations that earnest care which is necessary to prevent those principles from being contravened."

PROF. HERMANN MUNK has been elected president of the Berlin Physiological Society, in succession to the late Prof. Du Bois Reymond.

THE Swedish Academy of Agriculture of Stockholm has awarded its gold medal to Prof. J. Eriksson, for his researches on the rust of cereals.

A COMMITTEE has been formed to collect international subscriptions for the erection of a memorial to the late Prof. Galileo Ferraris in the Royal Industrial Museum, Turin.

The Prussian Academy of Sciences has elected Prof. Erns Ehlers, Professor of Zoology in Göttingen University, and Prof. G. Darboux, the distinguished French mathematician, to be corresponding members.

The American Academy of Arts and Sciences have elected as foreign members: Prof. Ludwig Boltzmann, professor of theoretical physics at Vienna; Prof. W. Pfeffer, professor of botany at Leipzig; and Dr. W. Dörpfeld, secretary of the German Imperial Archæological Institute at Athens.

The Naturalists' Association of Danzig has offered a prize for the best treatise on the origin and spread of fungus epidemics among insects which are injurious to the forests in West Prussia, and for the best means of applying them to the destruction of the insects. The papers are to be sent in by December 31, 1898.

At the recent annual meeting of the Sanitary Institute, H.R.H. the Duke of Cambridge, K.G., was re-elected President. Prof. W. H. Corfield and Mr. Thomas Salt were elected new Vice-Presidents, to fill the vacancies caused by the death of Sir George M. Humphry and Sir J. Russell Reynolds.

Mr. A. A. C. Swinton will give a paper on recent investigations in connection with X-rays, at the Camera Club, on April 12, when he will show a number of experiments illustrative of the properties of kathode and X-rays, and will exhibit a new and improved form of Crookes' tube he has designed for practical work. This tube is capable of easy adjustment, so as to give X-rays of any desired penetrative value.

Dr. Nansen was enthusiastically received at the Paris Geographical Society on Friday last, when he gave an account of his polar explorations. M. Rambaud, Minister of Education, presided, and, before the lecture, invested Dr. Nansen with the insignia of Commander of the Legion of Honour. Dr. Nansen also received the gold medal of the Society, and a medal from the Municipality of Paris.

Persistent efforts are being made in France by the Commission officielle pour la division décimale du temps et de la circonférence, to secure the adhesion of scientific societies to the division of the hours of the day into 100 parts, each to be again subdivided into 100 parts. This method of dividing time has evident advantages, but it also has its inconveniences; for instance, the C.G.S. unit of time, officially adopted at the International Congress of Electricians in 1881, would have to be discarded. To obtain an opinion upon the proposed decimal division of time, the Société Française de Physique has sent out a circular to its members, and has appointed a committee to consider the replies received, and to advise therefrom as to the action the Society should take.

The United States Government in 1895 appointed a "Deep Water-Ways Commission," for the purpose of making a preliminary investigation of the possibility of opening a deep waterway from the great lakes to the sea. This Commission has now reported that it is quite practicable to construct such canals as will be adequate to any scale of navigation that may be required between the great lakes and the sea; and recommend that the depth of any water-ways so constructed, should not be less than 20 feet. They also find that the most eligible route, starting from the heads of Lake Michigan and Superior, is through the several lakes and the proposed Niagara ship canal to Lake Ontario; and that the Canadian sea-board may be reached from Lake Ontario by way of the St. Lawrence; and the American sea-board by way of the St. Lawrence, and Lake Champlain, and the Hudson river; or by way of the Oswego-Oneida, Mohawk valley, and the Hudson river. They recommend that the Niagara ship canal should be first commenced, and that the other works required should be pushed on with as quickly as the projects can be matured; and that further surveys be undertaken, estimates of the cost prepared, and a systematic measurement of the outflow of the lakes undertaken. The cost of these investigations is estimated at about 126,000*l.*, and it will require two or three years to complete them. The President, in sending the report to Congress, advised that provision be made for carrying on the work of preliminary examination. The Canadian Government has also appointed a Commission to look into the question, and a joint session of the two Commissions was held at Detroit in last year.

The advantages of the absolute system of electric units have led Prof. Leonhard Weber to propose a similar system of units for photometric purposes. In the *Elektrotechnische Zeitschrift*, Prof. Weber points out that in photometry we have to deal with six different quantities, viz. intensity of light, flux of light, quantity of light, illumination, brightness and time-integral of illumination. Taking a *candle* as the unit of intensity, he shows how all these quantities can be expressed in terms of the candle, centimetre and second; or the candle, metre and hour. The objection to this proposed system, to our mind, is the adoption of a candle as one of the fundamental units; in order to obtain a perfectly absolute system of units, quantity of light should be measured in terms of the energy radiated, and the unit of intensity would then be that of a source from which the amount of energy radiating per unit solid angle per second was one erg. This would reduce all photometric quantities to the C.G.S. system of units.

Prof. A. Gray writes, with reference to his article in Nature of last week, that Lord Kelvin has called his attention to the fact that the account of Lord Kelvin's telephone-line and the establishment of telephony in Glasgow, is not quite exact. The telephone-line to Lord Kelvin's instrument-makers' was only one, and no doubt an early one, of a number of separate or independent lines which were established in Glasgow, and in other places, soon after the introduction of the telephone to this country by Prof. Graham Bell.

Messrs. Allen and Chapman, of New York, have just issued (extracted from the *Bulletin* of the American Museum of Natural History) an article on the "Mammals of Yucatan," where Mr. Chapman has lately made a brief stay. This dry and sparsely-wooded country has by no means a rich mammal-fauna; but during his short visit Mr. Chapman was able to secure examples of fifteen species, amongst which two or three rodents are described as new.

Messrs. Allen and Chapman also send us (extracted from the same periodical) an article on a collection of mammals made by Mr. Chapman, in Trinidad, during his trip to that island in 1894. The total number of mammals now recognised by the authors as found in Trinidad is about sixty-five species, of which forty are represented in the present collection. Of these a bat and three small rodents are referred to new species. Unfortunately, under the guise of priority, the American zoologists introduce so many new names into their recent works, that it is, in many cases, very difficult for their old-fashioned brethren of Europe to understand what they mean by them.

The latest contribution to the interesting subject of the primitive wild cattle of Europe is a short illustrated article, by Dr. A. Nehring, on Anton Wied's "Muscovia," a famous publication of the sixteenth century, in which a very incorrect figure of the urus was depicted. In the German edition of this work, by Herberstain, published in Vienna in 1557, characteristic figures are given of the European bison or wisent (*Bison europæus*) and of the urus (*Bos primigenius*); but the best illustration of the latter known to Prof. Nehring is that of a clever unknown artist of the first quarter of the sixteenth century, which was copied in

Griffiths' "Animal Kingdom," London, 1827 (vol. iv. p. 411). The above-mentioned illustrations are reproduced in Dr. Nehring's paper in *Globus*, Bd. lxxi. p. 85.

The *Annalen der Hydrographie und maritimen Meteorologie* or February, issued by the Deutsche Seewarte, contains a discussion of the storms of the western part of the South Atlantic Ocean, by E. Knipping, based upon the observations of 252 storms, mostly reported in the logs of German vessels. In higher latitudes than 30° S. only storms of hurricane force (11 and 12 of the Beaufort wind-scale), and in latitudes below 30° S. all storms of force 8 are included. The results show that no storm occurred to the east of 27° W. long. and north of 29° S. lat. The yearly distribution westward of 25° W. long. is very marked; for one storm in summer there are five in winter. The months of November to March are free from storms below 30° S. lat.; stormy trade-winds occur as far as 28° S., but only from April to October, and mostly with high and somewhat steady air-pressure. From 25° to 40° S. storms occur more frequently within a distance of 500 miles from the coast than beyond that area. In north-easterly storms the mean change of wind direction over the whole district amounts to 8 or 10 points of the compass in a left-hand direction, while in south-westerly storms there is little or no change of direction. In north-west storms below 30° S. there is little or no change, while above that latitude it amounts to 4 or 6 points to the left. The mean duration increases with the latitude; from 20° to 30° S. the north-easterly storms last twice as long, and from 30° to 40° S. only half as long as storms from other directions. The greatest force of the storms generally occurs with a rising barometer, *i.e. after* the time of the lowest reading, except in the case of easterly storms, when it occurs as frequently with a falling as with a rising barometer.

In May 1895, Mr. W. E. Wilson read a preliminary paper before the Royal Society, in which he described the apparatus and results of his investigation of the effect of pressure in the surrounding gas on the temperature of the crater of an electric arc. It may be remembered that the chief aim of the research was to determine, if possible, whether the temperature of the crater in the positive carbon varies when the pressure in the surrounding gas is changed. In a more recent investigation (*Astrophysical Journal*, vol. v. No. 2, p. 101), Messrs. Wilson and Fitzgerald give the results of further work on these points. These may be briefly summed up as follows:—That more evidence than they have obtained must be procured before they are able to affirm that either the temperature of the crater of the arc is raised or lowered by pressure. They, however, made some very concordant observations, which showed that the temperature was lowered with pressure, and in which at the time they could see no evidence of absorption by fog; but then, at other times, there were undoubted cases of absorption. "We certainly got no evidence that there is an appreciable increase of temperature." The best observations, the authors further say, "were made with variations of pressure from 15 up to 100 pounds per square inch, and there seems very little evidence of much change of radiation with this change of from 1 up to between 6 and 7 atmospheres."

Remarking on these interesting researches of Mr. Wilson, M. Guillaume writes that they seem to have shown that the temperature of the crater in the positive carbon is not limited to the boiling of carbon. Referring to the early researches of MM. Hannay and Hogarth (*Proc. R.S.*, vol. xxx. p. 178), and taking into account the recent investigation of M. P. Villard (*Journal de Physique*, vol. v. p. 453, 1896), M. Guillaume presented to the Physical Society of France, on July 20, 1896, the essence of a theory of the arc under pressure, based on the "dissolution du carbone dans le gaz ambiant." This idea seems to be in perfect harmony with the experiences of Violle, Wilson and Villard; and the fact observed by Wilson and Fitzgerald, that they "found that whenever the pressure was suddenly reduced there was a fog formed in the box, which cut off the light enormously," speaks well, as M. Guillaume says, for the accuracy of his theory. The temperature of carbon seems to be limited by the rapidity of the "dissolution" in the surrounding atmosphere, and ought to decrease when the pressure increases.

Mr. Asa S. Kinney has made a number of experiments for the purpose of obtaining some definite knowledge as to the influence of electricity upon plants, and his investigation forms the subject of *Bulletin* No. 43 of the Hatch Experiment Station of the Massachusetts College. The current employed was in some cases produced by four Leclanché cells, and in others by a Samson cell giving an electro-motive force of two and eighty-eight hundredth volts. An induction coil was used, so as to obtain a large variation in electro-motive force. The stimulation thus provided was applied to moistened seeds in glass jars, and upon filter papers. So far as the experiments go, they show that electricity exerts an appreciable influence upon the germination of seeds, the application of certain strengths of current to seeds for short periods of time apparently accelerating the processes of germination. As a result of experiment, it was found that at the end of twenty-four hours over 30 per cent. more seeds were germinated in the treated lots than in the normal. The range in the strength of current which accelerated germination seems to be exceedingly limited. The minimum strength of current, which just perceptibly accelerated germination when an interrupted induced current was used, probably represented considerably less than one volt. The optimum strength of current, which showed the maximum growth of radicles and hypocotyls, was equal to about three volts where an interrupted induced current was used. The maximum current which the seed germ could withstand without being destroyed was not ascertained, but it probably represents a comparatively high voltage. Arrangements were made to send an hourly current through the germinating seeds and growing plants, and it was found that the electricity did not lose its effect, but acted as a constant stimulation to their growth and development. The seeds used were of white mustard, red clover, rape, and barley, and measurements were made of about three thousand roots, and nearly one thousand stems.

Dr. W. A. Soga and Mr. H. Percy Browne have recently made some very important tests of the value of a certain fungus for destroying locusts by infecting them with it. The fungus is prepared by Dr. Edington, of the Bacteriological Institute, Grahamstown, and, judging from the experiments described in the Cape *Agricultural Journal*, great benefits may be expected to be derived by using it to infect locust swarms. A few locusts are caught and treated with the fungus; they are then set free, and inoculate other members of the swarm, with the result that in a few days the locusts die in large numbers.

The Summary Report for 1896 of the Geological Survey of Canada affords very interesting reading. The year has been marked by a notable development in mining, and by a remarkable discovery of corundum in a pegmatite in Ontario. The deep boring at Athabasca, described in the two last reports, has had to be abandoned after nearly 2000 feet of Cretaceous rocks had been sunk through, without the petroleum-beds being reached: the boring is not, however, a failure, as the knowledge gained will probably enable a successful boring to be made elsewhere. Mr. Chalmers, in Quebec province, finds evidence of extensive post-tertiary earth-movements in the many narrow lakes and uplifted shore-lines. In Nova Scotia, Prof. Bailey has successfully delimited the Devonian and Silurian formations, but has not been so fortunate with the supposed Cambrian (but unfossiliferous) rocks. Messrs. Barlow and Adams have carried modern methods and ideas into a survey of the classical Laurentian territory, but their work deserves more extensive notice than can now be given. We have also received the mineral statistics for 1895 from the same Survey.

BULLETIN 2, vol. ii. of the Geographical Club of Philadelphia, contains an account of a trip to Manikaland, by Mr. J. E. Farnum. The route followed the course of the Urema, which flows from Sungue Lake and joins the Pungue, about 45 miles above Fontisvilla, the starting-point of the railway to Salisbury. The country here, northwards to the Zambesi, and 150 miles south to the Bosi River, is perfectly flat, with scattered depressions, forming swamps during the greater part of the year. The soil is black sandy loam, supporting long grass, sometimes fifteen feet high, and a few palm trees; and in the drier parts dense tropical forest. Gutta-percha is obtained from one of the few creepers, and sold in small lumps to the Portuguese traders. The people are evidently degenerate, having few or no ceremonies or traditions of any kind.

WE have received Parts 2 and 3 of vol. xx. of the *Transactions and Proceedings* of the Botanical Society of Edinburgh, which give evidence of the continued activity of scientific research in the northern capital. Mr. R. S. McDougall has an elaborate paper on the poisonous properties of some Leguminous plants, especially of *Lathyrus sativus*. Mr. T. Cuthbert Day contributes an article on the germination of barley with restricted moisture, accompanied by a number of tables. In a valuable paper on the pigments of plants, by Miss M. J. Newbigin, the authoress attempts a classification of the colouring matter of flowers, and offers some suggestions with regard to their purpose in the physiology of the plant. But we would venture to suggest to the compilers of this and of some other journals, that the reviewer has scarcely a fair chance of appreciating their value when, as in the present instance, there is no kind of index or table of contents to each separate part, and even no descriptive headline to the pages.

A SERIES of articles upon the botanic gardens of the world is in course of appearance in the *Pharmaceutical Journal*. In the current number of the journal (March 27) an interesting article on the Royal Gardens at Kew is continued.

THE *Comptes rendus* of the meetings of the Congrès international des Pêches Maritimes, held at Sables-d'Olonné in September last, have just been published, as a volume of four hundred pages, by the Institut international de Bibliographie scientifique, Paris.

THE following are the arrangements for lectures on Tuesday evenings, at 8.30, at the Royal Victoria Hall, Waterloo-road S.E.:—April 6, Rev. George Henslow, on "The Movements of Plants"; April 13, Mr. F. W. Rudler, on "Modes of Mountain Making"; April 20, Prof. B. J. Malden, on "Africa up to date"; April 27, Dr. W. B. Benham, on "The Life of an Egg."

THE first number of the *Aeronautical Journal* has made its appearance. It is the organ of the Aeronautical Society of Great Britain, which is now undergoing resuscitation. Interest in flying and flying-machines, and atmospheric exploration, has lately received such a decided impetus, that the Society should have no difficulty in increasing its membership, or in obtaining topics for consideration.

A NEW quarterly magazine, devoted to subjects of general and permanent interest concerning "East Asia," which is the title it will bear, will appear in June. Articles will be contributed to the magazine on the past history and present condition of Eastern Asia; the buildings, institutions, and customs; th races of men; the plants and animals; the religion and literature; and on the voyages and adventures of old travellers. *East Asia* will be conducted by Mr. Henry Faulds, Fenton, Stoke-on-Trent, and published by Messrs. Marshall, Russell, and Co.

WE notice with satisfaction that *The Photogram* is endeavouring to make photographers into investigators, by presenting some of the results obtained by the use of photography. The applications of photography in the technology of explosives, in civil engineering, and in entomology, were dealt with in the first three numbers of this year, and the April number contains several fine illustrations of the effects produced on the surface and within the mass of liquid, when a liquid jet strikes the surface.

THE Association for the Harmonious Development of Faculties, an object which has the sympathy of all, if not the support, has followed up the publication of a sensible little pamphlet on "Common-sense Ethics" by another, on "Confucius: his life and his doctrine" (Williams and Norgate). The great Chinese philosopher used to send away his disciples who did not show sufficient ardour for study, or such as were not sufficiently intelligent to understand him. "When," said he, "I have shown a pupil one corner of the subject, and he is unable to discover the other three, I do not repeat my lesson." Confucius evidently understood the value of self-help.

THE Cheltenham College Natural History Society has issued a report of the proceedings during the year 1896. We welcome this, as we do all similar evidence of interest in science, and of observations made in the true spirit of inquiry. The sections of archæology, botany, entomology, geology, ornithology, and photography have all assisted in increasing the knowledge of the facts of nature, and the lectures, two of which, on "Argon and Helium" and "Cheltenham in the Old Days," appear in the report, have given the members of the Society something to think about. Too great encouragement cannot be given to such natural history societies as that at Cheltenham and other schools.

IF there is any book to which the word indispensable can be applied without being a figure of speech, it is the "Statesman's Year-Book" (Macmillan), the thirty-fourth annual publication of which we are pleased to announce. Under the editorship of Dr. J. Scott Keltie, assisted by Mr. J. P. A. Renwick, the book has become a unique statistical and historical annual of the states of the world. The present issue is a volume of 1167 pages, three hundred of which are devoted to the British Empire, and the remainder to foreign countries. To indicate the political changes which have taken place during the sixty years of Her Majesty's reign, eight pairs of coloured maps have been inserted, exhibiting, side by side, the political divisions of the continents in 1837 and 1897. It need hardly be said that the two maps of Africa, compared in this way, present a very striking difference. Other new features have been introduced, and the whole work stands out as a trustworthy and never-failing book of reference on political and commercial geography.

THE South London Entomological and Natural History Society has for many years cultivated the spirit of scientific observation, and added to the number of workers in the extensive field of natural history. The proceedings of the Society for the year 1896 testify to a condition of well-directed activity and sustained interest in the ways and works of nature. There are many noteworthy papers in the report, and they are made valuable by the fact that they record the results of direct observation. We note with satisfaction that Mr. Robert Adkin, in the course of his presidential address, points out how entomologists may assist in elucidating many problems of biology. He rightly remarks that, "Without entering very far into the philosophical phase of his subject, every practical entomologist has it in his power to contribute something towards solving one or the other of the problems connected with variation, heredity, and the general laws operating in the production of species. He is already expert at rearing insects from the egg; let him continue to do this, but let him conduct his rearing operations on experimental lines. . . . A useful course of experimental work would be to endeavour to develop some particular varietal tendency exhibited by a species."

THE spring announcements of the Cambridge University Press include:—The Collected Mathematical Papers of the late Arthur Cayley, F.R.S., to be completed in thirteen volumes, vol. xii.; The Scientific Papers of John Couch Adams, F.R.S., vol. ii., edited by Dr. W. G. Adams and R. A. Sampson; The Foundations of Geometry, by the Hon. B. Russell; A Treatise on Abel's Theorem, by H. F. Baker; The Theory of Groups of a Finite Order, by W. Burnside, F.R.S.; A Treatise on Universal Algebra, with some applications, by A. N. Whitehead. Vol. i. contains the General Principles of Algebraic Symbolism: The Algebra of Symbolic Logic: The Calculus of Extension (*i.e.* the Algebra of Graffmann's Ausdehnungslehre), with applications to Projective Geometry, to Non-Euclidean Geometry, and to Mathematical Physics; A Treatise on Octonions: a development of Clifford's Bi-Quaternions, by Prof. Alexander McAulay; A Treatise on Spherical Astronomy, by Prof. Sir Robert S. Ball, F.R.S.; A Treatise on Geometrical Optics, by R. A. Herman; An Elementary Course of Infinitesimal Calculus, for the use of Students of Physics and Engineering, by Prof. Horace Lamb, F.R.S.; Theoretical Mechanics: an introductory Treatise on the Principles of Dynamics, with numerous applications and examples, by A. E. H. Love, F.R.S.; The Works of Archimedes, edited in modern notation, with introductory chapters, by Dr. T. L Heath; Handbook to the Geology of Cambridgeshire, by F. R. Cowper Reed. Cambridge Natural Science Manuals.—(Biological Series) Fossil Plants: a Manual for Students of Botany and Geology, by A. C. Seward; The Vertebrate Skeleton, by S. H. Reynolds; Vertebrate Palæontology, by A. S. Woodward; (Physical Series) Electricity and Magnetism, by R. T. Glazebrook, F.R.S.; Sound, by J. W. Capstick; (Cambridge Geographical Series) A History of Ancient Geography, by the Rev. H. F. Tozer, with ten maps.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Levaillant's Cynictis (*Cynictis penicillata*), a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. J. E. Matcham; a Cheetah (*Cynælurus jubatus*) from Africa, presented by Colonel W. H. Wylde; a White-bellied Pangolin (*Manis tricuspis*) from Lagos, presented by Mr. F. W. Marshall; an Alexandrine Parrakeet (*Palæornis alexandri*, ♂) from India, presented by Mrs. Randall; a Severe Macaw (*Ara severa*) from South America, presented by Mrs. J. Keser; three Indian Pigmy Geese (*Nettopus coromandelianus*, ♂ ♂ ♀) from India, presented by Mr. Frank Finn; a Tesselated Snake (*Tropidonotus tesselatus*) from South Europe, presented by Mr. W. R. Temple; a Natal Python (*Python sebæ*, var) from South Africa, presented by Mr. Luscombe Searelle; three Purplish Death-Adders (*Pseudechis porphyriacus*), a Shielded Death-Adder (*Notechis scutatus*), three Australian Banded Snakes (*Diemenia nuchalis*), an Occipital Elaps (*Furina occipitalis*) from Australia, deposited; a Maximilian's Aracari (*Pteroglossus wiedi*) from Brazil; two Rosy-faced Love-Birds (*Agapornis roseicollis*) from South Africa, purchased; two Collared Fruit Bats (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PLANET MARS.—Prof. Schiaparelli has just published an account of his observations of Mars made during the years 1883–84. These observations are contained in the publication of the *Reale Accademia dei Lincei*, 1895–96, and are accompanied by a new chart of the surface-markings and eight diagrams of the planet's disc. Of the thirty-one canals seen to develop in 1881 and 1882, only eighteen have been observed again at this opposition, while seven new ones have been noted. In the polar gap a large dark rift was seen, apparently separating the snow into two unequal portions. An examination of the chart with that published by Lowell will be found to give many interesting points of difference. In the March number of the *Bulletin de la Société Astronomique de France* there will be found a brief account of these observations, with reproductions of the plates in Schiaparelli's original memoir. There are added a series of drawings of the planet observations, made from the Observatory of Juvisy, at the opposition in December last.

Some interesting observations, made of Mars last year, are contributed to the current number of the *Astronomischen Nachrichten* (No. 3411). The observer, Herr Leo Brenner, saw altogether 126 canals, 31 of which were new, while 13 and 82 were Lowell's and Schiaparelli's respectively. He gives, in a table, the positions of these new canals, remarking that he never saw any of the canals doubled. Five new seas were seen by him at positions B = 162° and +32°, C = 261° and +36°, D = 270° and +48°, E = 201° and +27°, 4 = 215° and +3°. The sea E had been previously seen by Antoniadi, who thought that it represented a doubling of Trivium. Propontis was seen doubled, the old one lying to the westward. On September 8 the last was seen of the south polar snow, and on the same date the north pole was distinctly observed. Nilosyrtis was bridged over as shown in Schiaparelli's map of the year 1882, but further to the south than is shown there. Several other points of interest were noted. A full account of these will be published in the *Kais. Akademie der Wissenschaft.*

In the same number of the *Astr. Nachr.*, mentioned above, M. V. Cerulli gives a brief account of his observations on Mars, made between October 1896 and January of this year.

DOUBLE-STAR MEASURES.—The *Astronomical Journal* (No. 397) gives the measures of several observers of double-stars. Prof. W. J. Hussey contributes measures of eighty different doubles made with the 12-inch and 36-inch of the Lick Observatory. The Morrison Observatory adds several more, measured by Mr. Henry S. Pritchett with the 12½-inch of that observatory. Mr. W. S. Eichelberger, of the Wesleyan University Observatory, Middletown, also publishes a few measures, but does not state the size of the instrument employed. Several bright objects among the southern stars, which have hitherto been supposed to be single, have now been proved to be double, according to Prof. T. J. J. See (*Astr. Nach.*, No. 3312). Further, several wide pairs have been resolved into triple systems of high interest. Three special cases of the former are mentioned, and as they seem likely to be of interest to other observers, we give the following data:—

ψ *Velorum*, discovered 1897 January 31.
α = 9h. 26m. 46·6s. = − 40° 1′ 50″·5 (1900·0
1897·084. Pos. angle 258°·8. Dist. 0″·54.
Mag. 5 and 5·1. Both yellow.

p Velorum, discovered 1897 January 10.
α = 10h. 33m. 6·5s. ∂ = − 47° 42′ 3″·9.
1897·065. Pos. angle 268°·9. Dist. 0″·47.
Mag. 4·6 and 5·2. Both yellow.

λ *Lupi*, discovered 1897 February 1.
α = 15h. 2m. 7·2s. ∂ = − 44° 53′ 31″·5.
1897·085. Pos. angle 178°·6. Dist. 0″·30.
Mag. 4·9 and 5·2. Both yellow.

BELGIUM OBSERVATORY ANNUAL.—The director of the Royal Belgium Observatory brings together in the annual for this year (the sixty-fourth year) a mass of useful information which will be serviceable to meteorologists as well as astronomers. In addition to the usual solar and planetary ephemerides, occultations, &c., Prof. F. Folie has written some short chapters on the following points:—A reaction in astronomy, accurate history of the discovery of diurnal nutation, explanations of the systematic differences between the Greenwich, Melbourne, and Cape catalogues by the diurnal nutation and the annual displacement of the pole of inertia, the probability of the existence of diurnal nutation from observations, Chandler's formulæ for computing the variations of latitude, planetary aberration, and the new method of reckoning time (one to twenty-four hours) on the railways. All that one can desire to know about the weather in Belgium during the past year will be found in the excellent summary given by the meteorological director of the observatory, M. A. Lancaster. Several interesting plates are given in his summary. Towards the end of the book various miscellaneous tables and yearly summaries will be found of general interest.

THE JAMES FORREST LECTURE—BACTERIOLOGY.

Dr. G. Sims Woodhead, Director of the Laboratories of the Conjoint Board of the Royal Colleges of Physicians and Surgeons, delivered the James Forrest Lecture before the Institution of Civil Engineers on March 18.

After a short introduction, the lecturer sketched briefly the history of bacteriology, and gave an account of Leeuwenhoek's observations, some of which were either directly or through his friends communicated to the Royal Society of London. The organisms described by Leeuwenhoek, in 1683, "were so small that they did not appear larger than represented at E (giving a copy of the figure). The motion of these little creatures, one among another, may be imagined like that of a great number of gnats or flies sporting in the air. From the appearance of these, to me, I judged that I saw some thousands of them in a portion of liquid no larger than a grain of sand, and this liquid consisted of eight parts water, and one part only of the before-mentioned substance taken from the teeth." Leeuwenhoek's microscopes magnified from 40 to 160 times. At that time he had not made up his mind as to the exact nature of these organisms; he spoke of them as living animalculæ, but in some of them he was unable to detect the slightest movement or any sign of life, nor did he theorise as to the meaning of the presence of these organisms in the situation in which he found them, though later, in 1713, he appeared to be under the impression that the organisms seen in the teeth were conveyed into the mouth by drinking-water that had been stored in barrels.

The various forms of bacteria were then briefly described, their size, structure, and mode of growth. Alterations in form were noted, and the marked differences, not only in minute structure, but in mode of growth, and in the nature of their products were indicated. The modifications in the sheath or covering of these organisms were demonstrated, and the frog, spawn, or living glue masses were explained. Fine flagella were shown in organisms that differed very widely as to their nature and functions, and it was pointed out that, from what we know, however, of other flagella and cilia, and from recent observations on the arrangement of the pores in the membrane, and the relation of the flagella to these pores, it is to be anticipated that they are usually, at any rate, processes directly continuous with the central protoplasm of the organism. At one time it was supposed that these flagella were formed only in organisms that have a special affinity for oxygen; but within the last couple of years it has been pointed out that the tetanus bacillus, the organism which grows best where free oxygen is excluded, often presents beautiful flagellated forms, although—and this is an important fact—the organism, as pointed out by Kanthack, remains non-motile when examined under the microscope in the presence of oxygen. How it behaves when oxygen is excluded, has not yet been determined. Even those which have an affinity for oxygen appear to lose their flagella as soon as they leave the surface, and no longer require to move about in order to obtain this substance.

Spore formation was fully described, and the great resistance that these "seed" spores present to heat and chemicals was noted. As an example of the importance of this spore formation, what takes place in the case of the splenic fever bacillus that is found in cattle was mentioned. When an ox dies of anthrax there are found in its blood an enormous number of short thick rods, the anthrax bacilli. If a drop of the blood be taken from a blood-vessel immediately after the death of the animal, the rods will be found, on microscopic examination, to contain no spores—that is, there are no bright points in the substance of the rod, and the animal, if buried at once before any blood or discharges from the body can get on to the land where the animal has died, will not be a source of infection; the putrefactive organisms that develop being sufficient to kill off the anthrax bacilli that are in the blood. If, however, the animal be cut into, and blood be allowed to escape so that the organisms come into contact with the air, and the condition of the blood is altered in such a way that the nutritive supply of these organisms is gradually cut off, spores immediately begin to develop in the bacilli, and, as soon as this takes place, it is an exceedingly difficult matter to get rid of the disease; mere burial is certainly not sufficient, as the spores are not affected by the putrefactive organisms and products—they retain their vitality, and only wait for more favourable conditions under which to become again developed into the active and virulent anthrax organism. The knowledge of this fact, of course, has a most important bearing on the treatment of carcases of animals that have succumbed to anthrax. Other forms of spores of a less resistent character have been described; but it is scarcely necessary to do more than mention them, as they are not yet accurately understood.

As to the effects of temperature upon micro-organisms, it has been found that most of the saprophytes (those that grow upon dead matter) flourish most luxuriantly at the ordinary temperature of water, whilst the parasite or disease-producing bacteria grow and multiply most rapidly at the temperature of their animal or plant hosts. Most of these are killed at a temperature of 60° C. (140° F.). Certain bacteria, however, especially those found in soil and river mud, develop readily at 60° or 70° C., and flourish most luxuriantly at 50° C. C. Globig, and also, quite recently, A. Macfadyen, have shown that there are numerous organisms which can exist at temperatures even higher than this, in spite of the fact that they contain no spores. Of the spore-bearing organisms Dr. Woodhead showed the tetanus and anthrax bacilli, both of which are pathogenic or disease-producing, and the bacillus subtilis or hay bacillus, which is found especially in hay infusions, and appears to be associated with the reduction of organic matter in the process of putrefaction.

The production of enzymes, of acids, and of gases was described to indicate what different functions these organisms may have; and the different ways in which the aerobes and anaerobes are able to take the elements they require for their nutrition, and for the carrying on of their special functions, were explained, and the importance of these processes in the transformation and breaking down of dead organic matter insisted upon. In nature the process of disintegration of such matter is divided essentially into three parts. It is necessary (1) to get all solid matter into solution; (2) to supply as large a quantity of oxygen in as short a time as possible to this organic matter; (3) to attack the organic matter in solution by means of micro-organisms, and to so break it up that the various elements of which this complex material is composed may be thrown into an unstable or nascent condition so that the oxygen present may have an opportunity of entering into combination, and of forming what are called oxidised substances. It is evident from what we know of putrefactive processes that these changes may take place in two perfectly different ways. In the one case we have the oxidation taking place directly, all the nascent substances being satisfied by the oxygen of the air, and the splitting up of the organic matter being carried on by aerobic organisms. In such a process of oxidation which takes place in porous soil well supplied with air and moisture, and also in water which is from time to time well saturated with oxygen, it will be found that little or no putrefactive odour is developed. The marsh gas, the sulphuretted hydrogen, and other similar substances as they are set free, rapidly combine with oxygen to form sulphuric acid, carbonic acid and water; the nitrogenous substances in a similar fashion combining to form nitrous and nitric acids. In the soil these acids combine with the various basic substances, lime, magnesia and the like, so that they are rapidly removed and the way is left clear for the formation of fresh batches of the same substances. In anaerobic putrefaction, on the other hand, the process does not go on in this unobtrusive fashion, the anaerobic organisms having, as it were, to wrest their oxygen from the organic molecules because there is no free oxygen present, set up a much greater disturbance, and the products of the decomposition, such as sulphuretted hydrogen, marsh gas and ammonia, are thrown off in an unoxidised condition, and in the free form (*i.e.* no longer in a nascent condition), they remain comparatively stable, and give rise to the odours so characteristic of rapid anaerobic putrefaction.

The action of light and air was discussed and illustrated, and the relation of nitrifying organisms to the enriching of the soil; the effect of certain organisms which have the power of taking nitrogen from the atmosphere, and of conveying it to plants, was also illustrated. The history of Spontaneous Generation was touched upon, especially in so far as the study of this will-o'-the-wisp had led to the advances in our knowledge of bacteriology.

In relation to disease, the part that bacteria play as ultimate causal factors was described as one of prime importance. If bacteriology had done nothing more for us than draw our attention to the concrete specific bacillus as a cause of cholera, or example, so as to allow us to concentrate our attention on special preventive measures, instead of leaving us to wander in the wilderness of "conditions of soil," of "atmospheric influences," of "epidemic waves," and the like, its value would have been amply demonstrated. Without undervaluing in the slightest degree the careful observations that have been made by eminent epidemiologists, whose work has a value which can only be enhanced by what can be added to it by the bacteriologist, it was pointed out that since Koch's investigations have been accepted as trustworthy, and as the basis on which preventive measures may be founded, we in this country, at any rate, through our admirably constituted Local Government Board, with its organised staff of medical officers and inspectors, have been able, without resorting to strict quarantine, to deal with the specific cases of cholera that have been brought to, or have appeared on, our shores in a fashion that even a few years ago could never have been anticipated. It was further insisted that whatever great predisposing causes may be at work, whatever subsoil, atmospheric, or other conditions may be necessary for the production of an epidemic disease in our midst, we have ample evidence that without the introduction of a special and specific causal agent from outside, we have never had an outbreak of this specific infective disease. Of course, in every outbreak there were men who came forward to show, on the one hand, that only Koch has right on his side, and, on the other, that all wisdom lies in Pettenkoffer's theory. But few seem to act as if, whatever they may believe, the observations of both should receive serious consideration. Seasonal variations, temperature, drainage, rise and fall of ground water, all play an important part in determining the conditions of growth of bacteria; whilst, on the other hand, bad ventilation and filth, famine and illness, all predispose patients to attack. But without the specific organisms that actually set up infective diseases, no infective diseases will occur. Celsus, the great physician, taught that predisposing causes alone were insufficient to set up disease; whilst, on the other hand, exciting causes by themselves were powerless to act. But when they came to act in combination, he maintained that they were both sure and far-reaching in the production of disease. The same applies to-day, whether we have to deal with diphtheria, typhoid, cholera, or tuberculosis. Pettenkoffer deals with predisposing causes and conditions, Koch with exciting factors—bacteria. When disease has not yet come amongst us, let us follow Pettenkoffer; but when it is in our midst, or in our immediate vicinity, Pasteur, Koch and Lister are immediately advanced to the position of more trustworthy guides and leaders.

Sixty years ago, the year of the accession of the Queen to the throne, the proof that the yeast plant was a living organism and the cause of the process of fermentation, was almost complete, whilst only a year later the germs of the silkworm disease were observed; but it was not until more than twenty years after that, that Pasteur was able to point out the full import of these discoveries. Pasteur's work on fermentation and on disease, his experiments on attenuation of organisms, on protective inoculation and on curative injection for hydrophobia, have already been referred to, and are so well known that it is unnecessary to do more than mention them. Koch was able, by his new methods of separating organisms and solid media, to go beyond Pasteur in isolating the anthrax bacillus, and in proving to absolute demonstration the relation of the anthrax bacillus to splenic fever. His ingenious methods of cultivating organisms, of staining them in tissues, and of separating the different species, created a new era in bacteriology.

In our own country we owe to Lord Lister the great advances that have been made in the treatment of wounds, by which thousands of lives are yearly preserved, advances which date entirely from his study of bacteria and bacteriology. Antiseptic surgery, like the antitoxic treatment of diphtheria, is based entirely upon the early researches on bacteriology, and its development has followed most closely the advances made in that subject. "As yet no one can say that we have reached even a resting-stage, and it behoves all those who desire to see advances made in the treatment and prevention of disease, whether in the department of protection and cure, with which medicine is specially concerned, or in the preventive department, with which you gentlemen as Civil Engineers have to deal, to continue to follow closely every new fact and every fresh theory arising out of new observations, in order that bacteria and the forces with which they are endowed may be made our well-disciplined servants, instead of being allowed to waste their energies as uncontrolled and uncontrollable masters."

THE PASTEUR MEMORIAL LECTURE OF THE CHEMICAL SOCIETY.

A SPECIAL meeting of the Chemical Society was held on Thursday evening, March 25, when Prof. Percy Frankland, F.R.S., delivered the Pasteur Memorial Lecture. Prof. Frankland commenced his discourse by pointing out that the consideration of Pasteur's work was a subject specially befitting the Chemical Society, inasmuch as he owed the training which enabled him to master so many and such various problems to that rigorous discipline to which in early years he was subjected in the pursuit of chemistry. Pasteur's interest in this science was exhibited at a very early age, and even when he was a lad at the provincial college of Arbois, his master cherished the ambition that he would one day occupy a chair at the famous École normale in Paris. This hope was well justified, for it was there that Pasteur, as assistant to M. Balard, commenced those epoch-making discoveries which have stimulated researches in, and practically founded, that fascinating and important branch of chemical science known as stereo-chemistry. Perhaps the most conclusive and eloquent testimony which we can have to the profound importance of Pasteur's researches in this direction is the tribute paid to them by one of his greatest followers, Emil Fischer, who acknowledged but a short time since that, despite the immense amount of work which has been subsequently carried out in this field, "there is hardly a new fact of fundamental importance which has been added to his discoveries."

It was at the École normale also that Pasteur, many years later, carried out his brilliant researches on the etiology of diseases. Pasteur was led to turn his attention to the study of fermentation phenomena by his removal to Lille, one of the leading industries of the district being the manufacture of alcohol from beetroot and grain; and in his desire to bring the work of his department into touch with local interests, he commenced that classical series of researches which he continued over a period of twenty years. In this field of inquiry he had his first passage of arms with the great Liebig; it is needless to say how Pasteur emerged victoriously from this contest, and succeeded in demolishing the chemical theory of fermentation processes which had been advanced and supported so eloquently by Liebig and other leading men of science of the day, and building up in its place that theory which the so-called "vitalists" had so long laboured ineffectually to establish. Pasteur's researches on fermentation also proved of enormous commercial benefit to France and the whole world, by indicating improved methods for the manufacture of vinegar, wine, and beer. Moreover, it was in the course of these inquiries that he established that process of preserving liquids by means of heat, now widely known as Pasteurisation. The story of the famous spontaneous generation controversy was told, and Prof. Frankland pointed out how, in pursuing the laborious investigations involved by his entering into this discussion, Pasteur was unconsciously preparing himself for the great work with which his name will always be associated—the inauguration of the modern system of preventive medicine. Already in his researches on diseases in silkworms, undertaken at the pressing request of his friend and former teacher Dumas, Pasteur was specially attracted by the question of contagion; and the valuable experience he gained in this work may be gathered from the fact that in later years, when any one presented himself and begged the privilege of being allowed to work in his laboratory, he used invariably to ask them if they had read his volume on silkworm diseases, and tell them that that was the best preparation they could have for working with him.

The five years which Pasteur spent upon this successful, though harassing, inquiry told terribly upon his health, and he was struck down by a paralytic seizure, from the physical effects of which he never absolutely recovered, though the clearness of his intellect was never for a moment impaired. His researches on silkworm diseases, and his long and intimate contact with fermentation phenomena, gradually paved the way for the momentous step which led him, at the already ripe age of fifty-five, to enter upon the study of diseases in the pursuit of which he was to win his most glorious laurels. Prof. Frankland described how Pasteur, after much hesitation, was led himself to embark upon this quest in consequence of his anxiety lest through exaggerated statements and undue haste in drawing conclusions—a tendency exhibited by many who at this time took up the bacteriological study of diseases—a reaction should be provoked, and the new ideas consequently fall into disfavour. Pasteur commenced his campaign by investigating the disease known as anthrax; but even while carrying on the most elaborate researches on this subject, he was turning in all directions for material to extend his studies on pathological phenomena. He walks the hospitals, armed with sterile vessels, to collect morbid products; he isolates the staphylococcus pyogenes; he visits the Maternity Hospital, and discovers the streptococcus pyogenes, asserting it to be the cause of puerperal fever. But the occupation of discovering pathogenic bacteria, fascinating as it was, could not permanently engross Pasteur's attention, and his ambition, stimulated by the contemplation of Jenner's great discovery, led him to seek a means of securing immunity from those diseases of which the specific viruses had been discovered, similar to that which his great predecessor had secured in the case of small-pox. Pasteur's discovery of a vaccine for fowl cholera was soon followed by vaccines for *Rouget de porc* or swine measles, and for anthrax, the saving to his country by the use of the anthrax vaccine alone having amounted to no less than 280,000*l.* in the course of the ten years from 1884 to 1894. The magnificent triumph which followed the discovery of these vaccines was, however, if possible, eclipsed by the elaboration of a cure for rabies; nearly 20,000 persons have undergone Pasteur's anti-rabic treatment, and the mortality amongst these treated persons has been less than 5 per 1000. The public expression of gratitude for this great discovery, concluded the lecturer, took the form of a general subscription, which rendered possible the foundation of the Institut Pasteur, which its great namesake had long cherished as a dream, and the realisation of which was the delight of his few remaining years; and here, under the auspices of Duclaux, Roux, Chamberland, and Metschnikoff, the sacred fire kindled by *le grand Maître* is still burning. Long may this flame be fed within the temple where now rests in eternal sleep that hero of science, whose greatest ambition was to be able, in his last hour, to pronounce the words, so simple in their form, so boundless in their aspiration, *j'ai fait ce que j'ai pu*.

THE DIAMOND MINES OF KIMBERLEY.[1]

IT is a standing surprise to the watchful outsider how little attention is bestowed on some of our colonies. For instance, to the Cape Colony, comprising vast, varied, and productive regions, we have till recently manifested profound ignorance and consequent indifference. When the Cape Colony was first incorporated with the Empire, it was pronounced "a bauble, unworthy of thanks." Yet before the Suez Canal and the Waghorn overland route to India, the Cape, as commanding our road to India, Australia, and China, had a special importance. Even now it presents an alternative route which under conceivable circumstances may be of capital moment.

The high grounds above Cape Town are rich in medicinal health-giving waters. The districts where these springs occur are high-lying, free from malaria, and admirably adapted for the restoration of invalids. It needs only some distinguished power to set the fashion, some emperor, prince, or reigning beauty to take the baths and drink the waters, and the tide of tourists would carry prosperity to Aliwal North, Fraserburg, Craddock, and Fort Beaufort.

From London to Kimberley by the Cape route is about 6700 miles, and is compassed in three weeks, although I would warmly recommend any one on pleasure bent to do as my wife and I did—spend a few days at Cape Town—before commencing the tedious railway journey to Kimberley.

[1] Two lectures delivered at the Imperial Institute, on November 16 and December 7, 1896, by Dr. William Crookes, F.R.S.

The famous diamond mines in the neighbourhood are Kimberley, De Beers, Dutoitspan, Bulfontein, and Wesselton. They are situated in latitude 28° 43′ South, and longitude 24° 46′ East. The town itself is 4042 feet above sea-level. Other mines in the neighbourhood are worked for diamonds, but as yet they are unimportant. Kimberley is practically in the centre of the present diamond-producing area. Besides these mines, two others of some importance in the Orange Free State are known as Jagersfontein and Coffeefontein, about sixty miles from the Kimberley diamond region.

KIMBERLEY.

The surface of the country round Kimberley is covered with a ferruginous red, adhesive, sandy soil, which makes horse traffic very heavy. Below the red soil is a basalt, much decomposed and highly ferruginous, from 20 to 90 feet thick, and lower still from 200 to 250 feet of black slaty shale containing carbon and iron pyrites. These are known as the Kimberley shales; they are very combustible, and in a part of the De Beers mine where they were accidentally fired, they smouldered for over eighteen months. Then follows a bed of conglomerate about 10 feet thick, and below the conglomerate about 400 feet of a hard compact rock of an olive colour, called "melaphyre" or olivine diabase. Below the melaphyre is a hard quartzite about 400 feet thick. The strata are almost horizontal, dipping slightly to the north: in places they are distorted and broken through by protruding dykes of trap. There is no water nearer than the Vaal river, about fourteen miles away, and formerly the miners were dependent on rain-water and a few springs and pools. Now, however, a constant and abundant supply of excellent water is served to the town, whilst good brick houses, with gardens and orchards, spring up on all sides. To mark the dizzy rate of progress, Kimberley has an excellent club and one of the best public libraries in South Africa. Parts of the town, affectionately called "the camp" by the older inhabitants, are not beyond the galvanised iron stage, and the general appearance is unlovely and depressing. Reunart reckons that over a million trees have been cut down to supply timber for the mines, and the whole country within a radius of 100 miles has been denuded of wood with the most injurious effects on the climate. The extreme dryness of the air, and the absence of trees to break the force of the wind and temper the heat of the sun, probably account for the dust storms so frequent in summer. The temperature in the day frequently rises to 100° in the shade, but in so dry a climate this is not unpleasant, and I felt less oppressed by this heat than I did in London the previous September. Moreover, in Kimberley, owing to the high altitude, the nights are always cool.

The approach to Kimberley is deadly dull. The country is almost treeless, and the bare veldt stretches its level length, relieved only by distant hills on the horizon.

THE PIPES.

The five diamond mines are all contained in a circle 3½ miles in diameter. They are irregularly shaped round or oval pipes, extending vertically downwards to an unknown depth, retaining about the same diameter throughout. They are said to be volcanic necks, filled from below with a heterogeneous mixture of fragments of the surrounding rocks, and of older rocks, such as granite, mingled and cemented with a bluish coloured hard clayey mass, in which famous blue clay the imbedded diamonds are hidden.

The breccia filling the mines, usually called "blue ground," is a collection of fragments of shale, various eruptive rocks, boulders, and crystals of many kinds of minerals. Indeed, a more heterogeneous mixture can hardly be found anywhere else on this globe. The ground mass is of a bluish-green, soapy to the touch, and friable, especially after exposure to the weather. Prof. Maskelyne considers it to be a hydrated bronzite with a little serpentine. Besides diamonds, Moissan has detected more than eighty species of minerals in the blue ground, the more common being:—Magnetite, ilmenite, garnet, bright green ferriferous enstatite (bronzite), a hornblendic mineral closely resembling smaragdite, calc-spar, vermiculite, diallage, jeffreysite, mica, kyanite, augite, peridot, iron pyrites, wollastonite, vaalite, zircon, chrome iron, rutile, corundum, apatite, olivine, sahlite, chromite, pseudobrookite, perofskite, biotite, and quartz. The blue ground does not show any signs of passing through great heat, as the fragments in the breccia are not fused at the edges. The eruptive force was probably steam or water-gas, acting under great pressure, but at no high temperature. According to Mr. Dunn, in the Kimberley mine, at a depth of 120 feet, several small fresh-water shells were discovered in what appeared to be undisturbed material.

The rock outside the pipes and encasing them is called "reef." Inside some of the mines occur large masses of "floating reef," covering an area of several thousand square feet. In the De Beers mine is what is called "the snake," a dyke of igneous rock taking a serpentine course across the mine, and standing like a vein nearly vertical, varying in thickness from 2 to 7 feet.

The areas of the mines are:—

Kimberley	33 acres
De Beers	22 ,,
Dutoitspan	45 ,,
Bulfontein	36 ,,

Before the discovery of the mines there was nothing in the superficial appearance of the ground to indicate the treasures below. Since the volcanic ducts were filled with the diamantiferous ground, denudation has planed the surface and the upper parts of the craters, and other ordinary signs of volcanic activity being smoothed away, the superficial and ubiquitous red sand covered the whole surface. The Kimberley mine seems to have presented a slight elevation above the surrounding flat country, while the sites of other mines were level or even slightly depressed. The Wesselton mine, within a mile of Dutoitspan, has only been discovered a few years. It showed a slight depression on the surface, which had been used as a shoot for dry rubbish. There are other diamantiferous pipes in the neighbourhood, but they are small, and do not contain stones in payable quantities. More recently another diamantiferous pipe has been discovered about forty miles off, near Klipdam, and is now worked as the Leicester mine. Other hoards of diamonds may also be near; where there are no surface signs, and the pipe itself is hidden under 10 or 20 feet of recent deposits, it is impossible to prospect the entire country. Accident has hitherto been the chief factor in the discovery of diamond mines.

How the great pipes were originally formed is hard to say. They were certainly not burst through in the ordinary manner of volcanic eruption, since the surrounding and enclosing walls show no signs of igneous action, and are not shattered or broken up even when touching the "blue ground." It is pretty certain these pipes were filled from below after they were pierced, and the diamonds were formed at some previous time and mixed with a mud volcano, together with all kinds of débris eroded from the rocks through which it erupted. The direction of flow is seen in the upturned edges of some of the strata of shale in the walls, although I was unable to see any upturning in most parts of the walls of the De Beers mine at great depths.

The Kimberley mine is filled for the first 70 or 80 feet with what is called "yellow ground," and below that with "blue ground." This superposed yellow on blue is common to all the mines. The blue is the unaltered ground, and owes its colour chiefly to the presence of lower oxides of iron. When atmospheric influences have access to the iron it is peroxidised, and the ground assumes a yellow colour. The thickness of yellow earth in the mines is therefore a measure of the depth of penetration of air and moisture. The colour does not affect the yield of diamonds.

The contents of the several pipes are not absolutely identical. The diamonds from each pipe differ in character, showing that the upflow was not simultaneous from one large reservoir below, but the result of several independent eruptions. Even in the same mine there are visible traces of more than one eruption.

The blue ground varies in its yield of diamonds in different mines, but it is pretty constant in the same mine. In 1890, the yield per load of blue ground was—

From the Kimberley mine	from	1·25 to 1·5	carats.
,, De Beers mine	,,	1·20 ,, 1·33	,,
,, Dutoitspan mine	,,	0·17 ,, 0·5	carat.
,, Bulfontein mine	,,	0·5 ,, 0·33	"

Both in Kimberley and De Beers the blue ground on the west side is poorer in diamonds than the blue ground in other parts of the mines. The diamonds from the west side also differ somewhat from those in other parts of the same mine. The diamonds from each mine have a distinctive character; so uniform are the characteristics that an experienced buyer can tell at once the locality of any particular parcel of stones. De Beers and Kimberley mines are distinguished by the yield of large yellowish crystals. Dutoitspan yields mainly coloured stones, while Bulfontein—half a mile off—produces small white stones, occasionally speckled and flawed, but rarely coloured. The diamonds from the Wesselton mine are nearly all irregular in shape; a perfect crystal is rare, and most of the stones are white, few yellow. The diamonds from the Leicester mine have a frosted, etched appearance; they are white, the crystallisation irregular ("cross-grained"), and they are very hard. Stones from Jagersfontein, in the Orange Free State, display great purity of colour and brilliancy; they have that so-called "steely" lustre characteristic of old Indian gems. Stones from this mine are worth nearly double those from Kimberley and De Beers.

In the first days of diamond mining there was no idea that diamantiferous earth extended to any particular depth, and miners were allowed to dig holes at haphazard, and prospect where they liked. When the Kimberley mine was discovered, a new arrangement was made, and in July 1871 it was cut up into about 500 claims, each 31 feet square, with spaces reserved for about fifteen roadways across the mine. No person at first could hold more than two claims—a rule afterwards modified.

It may help to realise the enormous value of the Kimberley mine if I tell you that two claims, measuring together 62 by 31 feet, and worked to a depth of 150 feet, yielded 28,000 carats of diamonds.

The roadways across the mine soon, however, became unsafe. Claims were sunk 100 or 200 feet each side of a roadway, and the temptation to undermine roadways was not always resisted. Falls of road frequently took place, followed by complete collapse, burying mine and claims in ruin. At that time there were probably 12,000 or 15,000 men at work in the mine, and then came the difficulty how to continue working the host of separate claims without interference with each other.

The mine was now threatened in two other quarters. The removal of the blue ground took away the support from the walls of the pipe, and frequent falls of reef occurred, not only covering up valuable claims with rubbish, but endangering the lives of workers below. Moreover, as the workings deepened, water made its appearance, necessitating pumping. In 1878 one quarter of the claims were covered by reef, and in 1879 over 300,000*l.* were spent on removing reef and water. In 1881 over 200,000*l.* were thus spent, and in 1882 more than half a million sterling was needed to defray the cost of reef removal. So matters went on until four million cubic yards of reef had been removed, at a cost of two millions sterling, and still little good was done, for out of 400 claims in the mine, only about 50 could be regularly worked. Ultimately, in November 1883, the biggest fall of reef on record took place, estimated at 250,000 cubic yards, surging half across the mine, where the bulk of it lies to this day. It became evident that open workings could not be carried on at such depths, and after many experiments the present system of underground working was devised.

During this time of perplexity, individual miners who could easily have worked one or two claims near the surface could not continue work in the face of harassing difficulties and heavy expenses. Thus the claims gradually changed hands, until the mine became the property first of a comparatively small number of capitalists, then of a smaller number of limited liability companies, until finally the whole of the mines have practically become the property of the "De Beers Consolidated Mines, Limited."

Underground Workings.

The system of underground working in use at the time of my visit is as follows:—Shafts are sunk in the solid rock at a sufficient distance from the pipe to be quite safe against reef movements in the open mine. The main shaft at De Beers starts about 540 feet from the north side of the mine, and is now over 1500 feet deep. Tunnels are driven from this shaft at different levels to cross the mine from west to east, about 120 feet apart. These tunnels are connected with each other by two tunnels running north and south, one near the west side of the mine and one midway between it and the east margin of the mine. From the east and west tunnels offsets are driven to the surrounding rock. When near the rock, they are widened into galleries, these in turn being stoped on the sides until they meet, and upwards until they break through the blue ground. The fallen reef with which the upper part of the mine is filled, sinks and partially fills the open space. The workmen then stand on the fallen reef, and drill the blue ground overhead; as the roof is blasted back the débris follows. When stoping between two tunnels, the blue is stoped up to the débris about midway between the two tunnels. The upper levels are worked back in advance of the lower levels, and the works assume the shape of irregular terraces. The main levels are from 90 to 120 feet apart, with intermediate levels every 30 feet. Hoisting is done from only one level at a time through the same shaft. By this ingenious method of mining, every portion of blue ground is excavated and raised to the surface, the rubbish on the top gradually sinking down and taking its place.

The scene below ground in the labyrinth of galleries is bewildering in its complexity, and is about as little like one's idea of a diamond mine as can well be conceived. Electric light is universal in the workings. One set of workers attends to the rock-drilling machines for blasting the blue ground; in other parts the blue is shovelled into wagons, which, when filled, are carried along rails by moving ropes till they get to the gallery, where the contents are sent to the surface.

At the bottom of the main shaft, at the 1300-foot level, the galleries converge to a large open space where the tram lines carrying the trucks meet. In front is a shoot to which the trucks full of blue ground are rapidly wheeled, tipped over, their contents discharged, when they are shunted to make way for other trucks. At the foot of the shoot is a skip holding 64 cubic feet, or four truck-loads. As soon as a skip has received its allotted four loads an electric bell sounds at the engine house, when the skip is hoisted to the surface and another takes its place. So the work proceeds, and on busy days ground has been hoisted at the rate of 20 loads every three minutes, equal to 400 loads an hour. In 1894 the record hoisting of blue ground at the Kimberley mine was 470 loads an hour; in one shift of eight hours 3312 loads; and in a day of three shifts, 7415 loads.

All below ground is dirty, muddy, grimy: half-naked men, black as ebony, muscular as athletes, with perspiration oozing from every pore, are seen in every direction, hammering, picking, shovelling, wheeling the trucks to and fro, keeping up a weird chant, which rises in force and melody when a titanic task requires excessive muscular strain. The whole scene is far more suggestive of a coal mine than a diamond mine, and all this mighty organisation, this strenuous expenditure of energy, this clever, costly machinery, this ceaseless toil of skilled and black labour, going on day and night, is just to win a few stones wherewith to deck my lady's finger!

At the four mines about 8000 persons are daily employed, namely, 1500 whites and 6500 blacks. The wages are—whites, 5*l.* or 6*l.* a week; blacks, underground, 4*s.* to 5*s.* a day, and above ground 21*s.* a week.

With gems like diamonds, where so large an intrinsic value is concentrated into so small a bulk, it is not surprising that robbery has to be guarded against in the most elaborate manner. The Illicit Diamond Buying (I.D.B.) laws are very stringent, and the searching, rendered easy by the "compounding" of the natives—which I shall describe presently—is of the most drastic character. It is, in fact, very difficult for a native employé to steal diamonds; even were he to succeed, it would be almost impossible to dispose of them, as a potential buyer would prefer to secure the safe reward for detecting a theft rather than run the serious risk of doing convict work on the Cape Town Breakwater for a couple of years.

The Depositing Floors.

Owing to the refractory character of blue ground fresh from the mines, it has to be exposed to atmospheric influences before it will pulverise under the action of water and mechanical treatment.

From the surface-boxes, into which the blue ground is tipped when it reaches the top of the main shaft, it is transferred to side-tipping trucks, and sent to the depositing floors by means of endless wire-rope haulage.

The depositing floors are prepared by removing the bush and grass from a fairly level piece of ground; this ground is then rolled smooth and hard. The floors extend over many square miles of country, and are surrounded by 7-foot barbed wire fences, vigilantly guarded day and night. The De Beers floors, on Kenilworth, are laid off in rectangular sections 600 yards long and 200 yards wide, each section holding about 50,000 loads. The ground from the Kimberley mine is the softest, and only needs a few months' exposure on the floors; the ground from De Beers is much harder, and requires at least six months' exposure; while some ground is so hard that it will not disintegrate by exposure to the weather under one or two years. The De Beers mine contains a much larger quantity of this hard blue ground than the other mines, and, in order to save the loss of time consequent on keeping an enormous stock of blue constantly on the floors, it has recently been decided to pass the harder and more refractory stuff direct from the mine through crushing mills.

For a time the blue ground remains on the floors without undergoing much alteration. But soon the heat of the sun and moisture produce a wonderful effect. Large pieces, hard as ordinary sandstone when taken from the mine, commence to crumble. At this stage the winning of the diamonds assumes more the nature of farming than mining. The ground is frequently harrowed and occasionally watered, to assist pulverisation by exposing the larger pieces to atmospheric influences. The length of time necessary for the ground to weather before it becomes sufficiently pulverised for washing depends on the season of the year and the amount of rain. The longer the ground remains exposed the better it is for washing.

In June 1895, the quantity of blue ground on the floors was 3,360,256 loads, representing diamonds to the value of nearly one million sterling. The risk of robbery at this stage of the operations is somewhat serious, and precautions are correspondingly elaborate. A native working on the floors may come across a large stone and secrete it about his person. Careful search soon reveals this crude form of robbery. Or he may hide it, note its position in the field, and after working hours creep back and furtively secure the prize. As a safeguard five powerful search-lights, each of 25,000 candle-power, sweep across the floors all night, and guards are on the watch to prevent any unauthorised person entering the mining area, and to prevent natives who are working at night from leaving the floors without being seen.

Washing and Concentrating Machinery.

After the blue ground has been weathered for a sufficient time, it is again loaded into trucks and hauled to the washing machinery.

About 14 per cent. of all the ground sent to the depositing floors are too hard to weather, so of late years crushing and concentrating plant has been erected to deal effectually with the hard lumps, thus saving the great lock-up of capital consequent on letting them lie on the floor a year or two.

The hard lumps being hauled to the upper part of the machine, are tipped into bins, whence they pass to crushing rollers which so reduce them that they will pass through a ring two inches in diameter. The coarse powder is screened through revolving cylinders having $\frac{1}{2}$ inch and $1\frac{1}{4}$ inch perforations. The stuff passing through the finer holes goes to the finishing mill, while the coarser stuff goes to smaller crushers. Before the coarse lumps are re-crushed they pass over revolving picking tables, where any specially large diamonds are rescued, thus preventing the risk of breakage. Finally the crushed and graded stuff goes to a series of jigs, and after further concentration the diamantiferous gravel is taken in locked trucks to the pulsators.

The Pulsator.

The pulsator is an ingeniously designed but somewhat complicated machine for dealing with the diamantiferous gravel already reduced one hundred times from the blue ground; the pulsator still further concentrating it till the gravel is rich enough to enable the stones to be picked out by hand. The value of the diamonds in a load of original blue ground being about 30*s.*, the gravel sent to the pulsator from the pans, reduced a hundredfold, is worth 150*l.* a load. Stuff of this value must not be exposed to risk of peculation. The locked trucks are hoisted by a cage to a platform, where they are unlocked, and their contents fed into a shoot leading to a cylinder. This cylinder is covered with iron plates perforated in sections with four sizes of round holes, $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, $\frac{1}{4}$ inch, and $\frac{3}{8}$ inch in diameter. That portion of the deposit too coarse to pass through the $\frac{3}{8}$-inch holes issues at the end of the cylinder, whence it goes direct to the sorting house. The four sizes which pass through the screens flow to the same number of jigs. The bottoms of the jigs are covered with screens the meshes of which are respectively ⅛ inch, 3/16 inch, ¼ inch, and ⅜ inch square, thus corresponding with, but being a little coarser than the holes in the cylinder. Upon each screen is spread a layer of bullets to prevent the rich deposit from passing too rapidly through the screens. The jigs themselves are stationary, but from below an intermittent stream of water passes in rapid pulsations with an up and down movement. This pulsation keeps the diamantiferous gravel constantly moving—"alive" is the expressive word used—and tends to sort out the constituents roughly according to their specific gravity, the heavier particles working to the bottom and the lighter material washing off by the flow of water and passing into trucks, whence it is carried to the tailings heap. The heavier portions by the up and down wash of the water gradually work their way under the bullets and pass through the screens into pointed boxes, whence the contents are drawn off at intervals and taken to the sorting room.

Sorting out.

The sorting room in the pulsator house is long, narrow, and well lighted. Here the rich gravel is brought in wet, a sieve-full at a time, and is dumped in a heap on tables covered with iron plates. The tables at one end take the coarsest lumps, next comes the gravel which passed the ⅜ inch holes, then the next in order, and so on. The first sorting is done by thoroughly trustworthy white men; for here the danger of robbery is greatest. Sweeping the heap of gravel to the right, the sorter scrapes a little of it to the centre of the table by means of a flat piece of sheet zinc. With this tool he rapidly passes in review the grains, seizes the diamonds and puts them into a little tin box in front of him. The stuff is then swept off to the left, and another lot taken, and so on till the sieve-full of gravel is exhausted, when another is brought in. The stuff the sorter has passed to his left as temporarily inspected is taken next to another part of the room, where it is again scrutinised by native convicts again and again, and whilst diamonds can be found in quantity sufficient to repay the cost of convict labour, it is passed under examination.

The diamond has a peculiar lustre, and on the sorter's table it is impossible to mistake it for any other stone that may be present. It looks somewhat like clear pieces of gum arabic, with a sort of intrinsic lustre which makes a conspicuous shine among the other stones.

Besides diamonds, the following associated minerals reach the sorting tables:—

Pyrope (garnet), sp. gr. 3·7, containing from 1·4 to 3 per cent. of oxide of chromium; zircon, in flesh-coloured grains, but no crystals, sp. gr. 4 to 4·7; kyanite, sp. gr. 3·45 to 3·7, discernible by its blue colour and perfect cleavage; chrome diopside, sp. gr. 3·23 to 3·5, of a bright green colour; bronzite, sp. gr. 3·1 to 3·3; magnetite, sp. gr. 4·9 to 5·2; mixed chrome and titanium iron ore, sp. gr. 4·4 to 4·9, containing from 13 to 61 per cent. of oxide of chromium, and from 3 to 68 per cent. of titanic acid, in changeable quantities; hornblende, sp. gr. 2·9 to 3·4; barytes, sp. gr. 4·3 to 4·7; and mica.

In the pulsator and sorting house most of the native labourers are long sentence convicts, supplied with food, clothing, and medical attendance by the company. These men are necessarily well guarded, and all the white men in the works carry revolvers. I myself saw about 1000 convicts at work. I was told that insubordination is very rare. Apart from the hopelessness of a successful rising, there is little inducement to revolt; the lot of these diamond workers is preferable to life in the Government prisons, and they seem contented.

Sometimes as many as 8000 carats of diamonds come from the pulsator in one day, representing about 10,000*l*. in value.

Prodigious diamonds are not so uncommon as is generally supposed. Diamonds weighing over an ounce (151·5 carats) are not unfrequent at Kimberley, and, were it necessary, there would be no difficulty in getting together a hundred of them. Not long ago, in one parcel of stones at Wernher, Beit, and Co.'s office, I saw eight perfect ounce crystals, and one weighing two ounces. The largest diamond from the Kimberley mines weighed 428½ carats, or nearly 4 ounces troy. It measured 1⅞ inch through the longest axis, and was 1½ inch square. After cutting, it weighed 228½ carats, losing 200 carats in the process. The largest known diamond weighs 970 carats—over half a pound. It was found at the Jagersfontein mine. Diamonds smaller than a small fraction of a grain elude the sorters and are lost. A microscopic examination of blue ground from Kimberley, after treatment with appropriate solvents, shows the presence of microscopic diamonds, white, coloured, and black, also of boart and carbonado.

The Diamond Office.

From the pulsator the diamonds are sent to the general office in Kimberley to be cleansed in a boiling mixture of nitric and sulphuric acids. A parcel of diamonds loses about half a part per 1000 by this treatment.

After purification, the diamonds are handed to the valuators, who sort them into classes, according to size, colour, and purity. In the diamond office they are sorted into ten classes. In the year 1895 in 1141·8 carats of stones, the proportions of the different classes were as follows:—

Close goods (best stones)	53·8
Spotted stones	75·8
Fine cleavage	79·1
Flats	39·5
Macles	36·5
Ordinary and rejection cleavage	243·4
Rejection stones	43·2
Light and brown cleavage	56·9
Rubbish	371·8
	1000·0
Fine sand	141·8
	1141·8

From two to three million carats of diamonds are turned out of the De Beers mines in a year, and as five million carats go to the ton, this represents half a ton of diamonds. To the end of 1892, ten tons of diamonds had come from these mines, valued at 60,000,000*l*. sterling. This mass of blazing diamonds could be accommodated in a box five feet square and six feet high.

In the year ending June 1895, there were found 2,435,541½ carats of diamonds, realising 3,105,958*l*. During the same time the total expenditure amounted to 1,704,813*l*., leaving a profit of 1,401,145*l*.

About half these expenses represent mine wages or other local expenses.

The De Beers Company could raise many more diamonds, but a superfluity would have the effect of lowering the price. The diamond is a luxury, and there is only a limited demand for it throughout the world. From 4 to 4½ millions sterling is as much as is spent annually in diamonds; if the production is not regulated by the demand, there will be over-production, and the trade will suffer. By regulating the output the directors have succeeded in maintaining prices since the consolidation in 1888.

Diamonds to the value of about a million annually are produced by outside companies and individuals.

The Compound System.

One great safeguard against robbery is the "compound" system of looking after the natives. A "compound" is a large square, about 20 acres in extent, surrounded by rows of one-storey buildings of corrugated iron. These are divided into rooms holding each about twenty natives. A high iron fence is erected around the compound, 10 feet from the buildings. Within the enclosure is a store, where the necessaries of life are supplied to the natives at a reduced price, wood and water being provided free of charge. In the middle is a large swimming-bath, with fresh water running through it. The rest of the space is devoted to recreation, games, dances, concerts, and any other amusement the native mind can desire. In case of accident or illness there is a well-appointed hospital, where the sick are tended. Medical supervision, nurses, and food are supplied free by the Company.

In the compound are to be seen nearly all the best types of African tribes. Each tribe keeps to itself, and to go round the buildings skirting the compound is an admirable object-lesson in ethnology. At one part is a group of Zulus; next we come to Fingoes; then Basutos; beyond come Matabele, Bechuanas, Pondos, Shangains, Swazis, and other less-known tribes, each forming a group by itself, or wandering about making friendly calls.

The clothing in the compound is diverse and original. Some of the men are great dandies; others think that in so hot a climate a bright coloured pocket-handkerchief is as great a compliance with the requirements of civilisation as can be expected.

They get very good wages, varying according to the work. The work is appreciated, and there are always more applicants than can be accepted. On entering, the restrictions to which they must submit are fully explained, and they are required to sign for three months at least, during which time they must not leave the compound or mine. A covered way and tunnel lead the workers underground to the down shaft, while those working on the depositing floors go and come under guard. It is seldom that a man does not return, once he has lived the life in the compound; some come again and again for years, only leaving occasionally to spend accumulated savings. Some of the careful men contrive to save money. They carry it at intervals to Captain Dallas to keep for them. Occasionally they ask to look at their savings, which may amount to 30*l.* or 40*l.*, accumulated by driblets. They are ignorant of savings banks or interest, and are content if they see their own money in the original rags and papers in which it was handed in. Sometimes Captain Dallas will have as much as 1000*l.* of these savings in his care. On leaving, the men generally draw all their savings, and it is not uncommon for a grateful Kaffir to press 2*l.* or 3*l.* on Captain Dallas in recognition of his trouble. They are astonished when their offerings are declined; still more so when it is explained that if they would put their savings in a bank, they would have a few extra pounds given to them for the privilege of taking care of it. Bank accounts are beyond them. The Kaffir, on demand, must behold his coins just as he handed them in, wrappings and all.

So much then for the diamond mining industry of Kimberley as I found it on my visit in the early part of 1896. I trust I have made you realise something of the daily life of the diamond miners, of the skill and ingenuity with which their labours are controlled, and of the vicissitudes through which a diamond must pass before it is fit to blaze in a ring or a tiara.

As for myself, I like to look back on our visit, and I am glad we made the journey. I like to recall the dusky natives at work and at play, with their smiling, good-natured faces. And I am glad to have seen that Arabian Nights vision, the strong room of the De Beers Company, literally heaped with stones won from the blue ground, purified, flashing, and of inestimable price, ready to play their part in the lives of men and women. And above all, I like to recall the friendly welcome, the thousand acts of kindness shown us by our able and enterprising colonial fellow countrymen.

The Diamond.

I will briefly survey the chief chemical and physical characteristics of the diamond. I need scarcely say it is almost pure carbon, and is the hardest substance in nature. When heated in air or oxygen to a temperature varying from 760° to 875° C., according to its hardness, the diamond burns with production of carbonic acid. It leaves an extremely light ash, sometimes retaining the shape of the crystal, consisting of iron, lime, magnesia, silica, and titanium. In boart and carbonado, the amount of ash sometimes rises to 4 per cent., but in clear crystallised diamonds it is seldom higher than 0·05 per cent. By far the largest constituent of the ash is iron.

The specific gravity of the diamond is from 3·514 to 3·518. For comparison, I give in tabular form the specific gravities of the different varieties of carbon:—

Amorphous carbon	1·45 to 1·70
Graphite	2·11 ,, 2·26
Hard gas coke	2·356
Boart	3·47 ,, 3·49
Carbonado	3·50
Diamond	3·514 ,, 3·518

The diamond crystallises in octahedra. It frequently occurs with curved faces and edges. Twin crystals (macles) are not uncommon. The crystals frequently contain microscopic cavities, and Brewster, by means of polarised light, found that the diamond round these cavities showed evidence of strain, as if from the presence of included gas at high pressure.

Some crystals of diamonds have their surfaces beautifully marked with equilateral triangles, interlaced and of varying sizes. Under the microscope these markings appear as shallow depressions sharply cut out of the surrounding surface, and these depressions were supposed by Gustav Rose to indicate the probability that the diamonds had at some previous time been exposed to incipient combustion. Rose pointed out that similar triangular striations appeared on the surfaces of diamonds burnt before the blowpipe. I have satisfied myself that during combustion before the blowpipe, in the field of a microscope, the surface is etched with triangular markings very different in character from those naturally on crystals. The artificial striæ are much smaller and massed closer together, looking as if the diamond during combustion flaked away in triangular chips, while the markings natural to crystals appear as if produced by the crystallising force as they were being built up. Many crystals of chemical compounds, alum, for instance, appear striated from both these causes. Geometrical markings can be produced by eroding the surface of a crystal with water, and they also occur naturally during crystallisation.

Some diamonds have enclosed in their substance black uncrystallised particles of graphite. There also occur what may be considered intermediate forms between the well-crystallised diamond and graphite. These are "boart" and "carbonado." Boart is an imperfectly crystallised form of diamond, having no clear portions, therefore being useless for gems. Boart is frequently found in spherical globules, and may be of all colours. Being very hard it is used in rock-drilling, and, when crushed, for cutting and polishing other stones. Carbonado is the Brazilian term for a still less perfectly crystallised form of carbon. It is equally hard, and occurs in porous masses, and in massive black pebbles, sometimes weighing a couple or more ounces.

Many diamonds after exposure for some time to the sun give out light when viewed in a dark room. Some diamonds are fluorescent, appearing milky in sunlight. In a vacuum, exposed to a high-tension current of electricity, diamonds phosphoresce of different colours. In these circumstances most South African diamonds shine with a bluish light. Diamonds from other localities shine with different colours, such as bright blue, apricot, pale blue, red, yellowish green, orange, and pale green. The most phosphorescent diamonds are those which are fluorescent in the sun. One beautiful green diamond in my collection, when phosphorescing in a good vacuum, gives almost as much light as a candle; the light is pale green—almost white.

During molecular bombardment the diamond becomes discoloured, and in course of time becomes black on the surface. Some diamonds blacken in the course of a few minutes, while others require an hour or more to discolour. This blackening is only superficial, and although no ordinary means of cleaning will remove the discolouration, it goes at once when the stone is polished with diamond powder. Ordinary oxidising reagents have little or no effect in restoring the colour. The black stain on the diamond is not due to a layer of amorphous carbon, but to graphite, which is much more resistent to oxidation. It is not necessary to expose the diamond in a vacuum to electrical excitement in order to produce a change. Some diamonds phosphoresce when exposed to the sun's rays or to an electrical discharge in the air, and many more are phosphorescent when exposed to the Röntgen rays. In the latter case a slight superficial blackening also takes place.

The diamond is remarkable in another respect. It is extremely transparent to the Röntgen rays, whereas highly refracting glass, used in imitation diamonds, is almost perfectly opaque to them. I exposed a flat plate of diamond, 0·0786 inch thick, and in shape a perfect equilateral triangle, side by side with a piece of glass of the same shape and thickness, over a photographic plate to the X-rays for a few seconds. On development the impression was found to be very feeble where the diamond obscured the rays, showing that most passed through, while the glass was seen to have obstructed all of them.

By this means imitation diamonds and some other false gems can readily be identified and distinguished from the true gems.

Diamonds occur in all shades, from deep yellow to pure white and jet black, from deep brown to light cinnamon, also green, blue, pink, yellow, orange, and opaque.

I have shown how interesting is Kimberley with reference to its buried diamond wealth. The enormous find and exportation of diamonds must bring reciprocal benefit; and it would redound to our credit could we honourably do our part towards the pacification and development of the colony.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Prof. W. J. Sollas, F.R.S., Professor of Geology in the University of Dublin, and late Fellow of St. John's College, Cambridge, has been elected to succeed the late Prof. Green as Professor of Geology.

In a Convocation to be held on Tuesday, May 11, the decree will be proposed that the gift of a very large and valuable collection of butterflies, offered by Mr. F. du Cane Godman, F.R.S., and Mr. Osbert Salvin, F.R.S., to the Hope Department, be accepted by the University. Prof. E. B. Poulton, the Hope Professor, states that the specimens in this collection are of especial value because of the excellent geographical data which accompany them. Although specimens from all countries are included, the collection is especially rich in species from Central America, a district of peculiar interest, hitherto but poorly represented in the Hope Collection. Many specimens of historic interest are also present—the captures of Bates in Brazil, of Belt in Nicaragua, and of Wallace in the Malay Archipelago. The majority of the more recently captured specimens were taken by the greatest living collectors, such as G. C. Champion and H. H. Smith (Central America), and C. M. Woodford (Solomon Islands); so that all localities can be entirely depended upon. No conditions are attached to the gift, so that the specimens can be at once incorporated with those of the General Collection, as soon as they have been adequately labelled. The collection also contains a large amount of material which will be available to illustrate the principles of protective mimicry, geographical distribution, isolation, &c.

An anonymous donor has given 25,000 dols. to the Brooklyn Polytechnic Institute.

Dr. Wallis Budge has received the *ad eundum* degree of D.Litt. from the University of Durham.

The chair of Natural Philosophy in Queen's College, Belfast, vacant by the retirement of Prof. Everett, has been filled by the appointment of Mr. W. B. Morton, of Queen's College, Belfast, and St. John's College, Cambridge.

The Congrès International de l'Enseignement Technique has accepted an invitation from the Society of Arts, and certain of the City Guilds, to hold its meeting this year in London. The Congress will be opened on June 15.

Prof. C. Claus, Professor of Zoology at the Vienna University, has resigned; Dr. B. Hatschek, of Prague, has been made his successor in Vienna; and Prof. R. van Leudenfeld has been appointed to fill the chair of Zoology in the latter's place at Prague.

The University of St. Andrews has conferred the honorary degree of LL.D. upon Mr. J. Scott Keltie, Secretary to the Geographical Society; Prof. H. S. Hele-Shaw, Professor of Engineering in University College, Liverpool; and the Rev. Alfred Merle Norman, F.R.S., Hon. Canon of Durham.

A meeting will be held at Hugh Myddelton Board School, Clerkenwell, on Saturday next, April 3, at 3.30, to consider improvements in the methods of teaching domestic economy as commonly practised in schools. It will be proposed that in future the teaching should be of an exact nature, and such as to make the scholars think for themselves about the ordinary affairs of the household. For this end to be attained, simple but accurate experimental work dealing with domestic matters should be introduced into girls' schools. The Education Department have given their recognition to this view by introducing a new subject—domestic science—into the Code of Elementary Schools.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, February.—Prof. A. W. Phillips contributes an obituary sketch of Prof. H. A. Newton, who died August 12, 1896. After pointing out, in some detail, his various lines of work, he closes thus:—"The achievements of Prof. Newton, great as they were from a scientific standpoint, give no adequate idea, taken in themselves, of his power and influence. He built up, during a leadership of forty years, a strong and symmetrical department of mathematics, by his comprehensive grasp of the trend of mathematical thought, and by his wonderful power of divining the paths which lead out to fruitful fields of research, both within the domain of pure mathematics and in its applications to other sciences. Nor was the first part of his academic activities merely in his own department of studies. In moulding the general policy of the institution, his counsel was invaluable; in establishing and maintaining the moral and intellectual standards, his influence was pre-eminent; the University bears the indelible impress of a life consecrated to the development of the noblest ideals."—Transcendental numbers is the translation, by Prof. W. W. Beman, of chapter xxv. of vol. ii. of Prof. H. Weber's Lehrbuch der Algebra. This is a fairly elementary presentation of the recent methods of demonstrating the transcendency of e and π. The sections treat of enumerable masses (a mass is said to be enumerable when its elements can be brought into a (1, 1) correspondence with the whole series of natural numbers, or a portion of the same), unenumerable masses, transcendency of e and of π, and Lindemann's general theorem regarding the exponential function.—Shorter notices are a review of Dr. Schwatt's geometrical treatment of curves which are isogonal conjugates to a straight line with respect to a triangle. Part i. (Boston, 1895), by Prof. F. Morley, of the annuaire pour l'An 1897, publié par le Bureau des Longitudes, by Prof. E. W. Brown.—Members of the Society resident in, or near, Chicago, held a mathematical conference at the University of Chicago on December 31, 1896, and January 1, 1897, and in future it is proposed to hold at least two similar meetings in the year, viz. during the Christmas vacation, and in the spring.—The titles of the papers read are given, with notes and new publications.

Wiedemann's Annalen der Physik und Chemie, No. 3.—Behaviour of quartz towards infra-red rays, by E. F. Nichols. This was investigated not by a bolometer or a thermo-element, but by a modified form of Crookes' radiometer, in which one of the vanes was screened and the other exposed to the rays reflected or transmitted by quartz. The rays, which were concentrated by a rock-salt lens and admitted to the radiometer through a fluorspar window, produced a torsion of the suspending quartz fibre, which was indicated by a mirror attached to the vanes. The reflection by quartz of light of the wave-length 7·4 μ is only 0·29 per cent. But at 8·45 μ it rivals that of burnished silver, 75 per cent. The transmission curve is very irregular, and beyond 8·1 μ no light is transmitted.—Heat rays of great wave-length, by H. Rubens and E. F. Nichols. Instead of using a grating or selective absorption for obtaining infra-red rays, the authors filtered them out by three successive reflections from surfaces of fluorspar or rock-salt, the source being a layer of the same substance on hot platinum foil. Heat rays of hitherto unrecorded length were thus obtained. The fluorite reflections gave waves of 24·5 μ, or over 30 times the length of the extreme red light waves. They are, reckoning by octaves, midway between the shortest ultra-violet waves and the shortest electrical waves (6 mm.) hitherto observed. Reflections from rock-salt gave waves of 50 μ.—Thermometer for very low temperatures, by F. Kohlrausch. Such a thermometer may be procured by the use of petroleum ether as the thermometric substance. It is very viscous but still sufficiently liquid at the temperature of boiling liquid air (−190° C.), and shows a contraction of volume by as much as 25 per cent. from the ordinary to the lowest temperature. Amylene also remains liquid, but is more viscous.—Visibility of Röntgen rays, by G. Brandes and E. Dorn. When the vacuum tube is highly exhausted, the rays produce a sensation of light in most eyes, which is, however, difficult to localise. Most of the humours of the eye absorb the rays.—Interference surfaces at the kathode, and the electrostatic deflection of the kathode rays, by E. Wiedemann and G. C. Schmidt. The deflections of kathode rays observed by Jaumann are a secondary effect due to a modification of the field by the charged body, which produces a shifting of the origin of the rays on the kathode.—Demonstration of the course of variable currents, by F. Braun. A method by which the inertia of the indicator may be got rid of consists in making the current traverse an electro-magnet which deflects the kathode rays in a vacuum tube. The spot of light on a fluorescent screen vibrates, and the form of the vibration curve is studied by a revolving mirror.—Also papers by Dorn, Völlmer, Goldstein, Drude, König, Loomis, Voigt, and Glan.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 4.—"Luminosity and Photometry." By John Berry Haycraft, M.D., University College, Cardiff.

The luminosity of the spectrum was determined by the method of the "minimal effective stimulus," the portions of the spectrum investigated being as a physical quantity reduced in amount until its effect on the visual apparatus was just apparent. The luminosity was also determined by the "flickering" method. A rotating semi-disc periodically cut off the spectral ray, and produced flickering, which flickering disappeared after a certain speed of rotation had been reached: the speed of this rotation was taken as a measure of the luminosity. The curves obtained by these methods agreed with each other and with curves obtained by methods of "inspection" used by Abney and König. The curves obtained with the dark adapted eye—the observer was kept in a dark room during and for an hour before the experiment—gave a maximum in the green in the case of the minimal effective stimulus. With the light adapted eye—the room was whitewashed and lit by gas—the yellow of the spectrum was the most luminous. With the flicker method the curve of a spectrum of low physical luminosity has a maximum in the green, the curve of a spectrum of high luminosity in the yellow. Purkinje's phenomenon was also studied by the above methods, using coloured papers and a graduated gas-burner to vary the luminosity. The full paper will shortly appear in the *Journal of Physiology*.

Physical Society, March 26.—Mr. Shelford Bidwell, President, in the chair. At the invitation of Dr. S. P. Thompson, the meeting was held at the Technical College, Leonard Street, Finsbury. Mr. Rollo Appleyard read a paper on liquid coherers and mobile conductors, and showed the following experiments: (1) A glass tube, containing mercury and paraffin-oil, is shaken up until the mercury divides into small spheroids. The resistance of the chain of spheroids under these conditions is several megohms. Coherence can be brought about by a direct current, a spark, or by a Hertz oscillator. The coherence is visible, the spheroids forming into large globules. At the same time, the resistance falls to a fraction of an ohm. (2) An unstable emulsion is formed by shaking water and paraffin oil together, in a glass tube; called by the author a "rain" tube. The oil may be coloured with alkanet root. By electrification, the water suspended in the oil is suddenly precipitated in a shower through the oil, precisely as rain is precipitated in the air, after thunder. (3) A mixture of paraffin oil and water is poured into a photographic dish, just covering the bottom; and a little mercury is poured in. Any two separate globules of mercury in the dish are then connected by wires to a battery of about 200 volts, through a reversing-key. A momentary tap of the key causes instantaneous deformation of the mercury, especially of the globule connected to the negative pole. If the current is kept on, the negative globule sends forth a long tentacle of mercury across the dish to the positive globule. The tentacle may break into spheroids. Intermediate globules send forth "fingers" towards the positive terminal globule; and, by continued application of the current, the "fingers" link intermediate globules; illustrating the nature of liquid coherence. By using the current-reverser as a telegraphic transmitting-key, the motions, to right or left, of the "finger" of any stray globule may be interpreted to form the letters of the Morse code. By a succession of taps of the key in one direction or the other, a globule can be made to "caterpillar" along the dish. Prof. Ramsay said he had once attempted to facilitate churning by the application of 8 or 9 volts to some milk. He thought the cream came a little faster, but it turned sour very quickly. Prof. Fitzgerald thought that the effects observed in experiment (3) were the result of current, and not of electro-static changes, and he would like to know the value of the actual current used. There was no doubt that the motions were due to variations in capillarity. Mr. Shelford Bidwell asked how the mercury was formed into spheroids in the tube in experiment (1). Mr. Appleyard, in replying to Prof. Fitzgerald, said it was not easy to define the circuit, as the terminal-globules were rather capricious, but he would try and measure the current in some particular case. The mercury-tube in experiment (1) was shaken in a horizontal plane; the operation took about ten minutes. Equal volumes of mercury and oil was a good proportion. One-quarter of the length of the tube should be left as an air-space.—Prof. Dalby then exhibited five pieces of apparatus: (1) a kinematic slide, (2) an inertia apparatus with trifilar suspension, (3) a Wilberforce spring, (4) an Ewing's reading-telescope, (5) a kinematic Hook-gauge. Models (1), (2), (4), and (5) illustrated the various degrees of freedom of bodies restrained at different numbers of points. It was shown with (3), that in extending a spiral spring there results a certain amount of twisting. If a mass is hung at the lower end of the spiral in such a way that, when suddenly released after extension of the spring, the time of oscillation of the mass in the horizontal plane (rotation) is the same as the time of vertical oscillation, then the tendency to twist results in a change of energy which alternates between the rotary and linear forms. Mr. Boys drew attention to the conditions of restraint, and suggested a criterion for determining whether a piece of mechanism was designed for minimum strain on the structure: a thin wedge slipped under any one point of contact should not disturb the other points of restraint. Prof. Fitzgerald pointed out the effect of symmetry upon the motion of the spring of (5). The spiral happened to be an unsymmetrical form; the change of phase from vertical to rotary oscillation was therefore rapid. In the case of the vibration of a symmetrical stretched cord the change of phase would be very slow.—Dr. Thompson exhibited two kinematic models depending upon the principle that any simple harmonic motion may be considered as the resultant of two oppositely-directed motions. The first illustrates the synthesis of two opposite circular motions of equal period and amplitude to form a straight-line motion; the second shows the combination of two simple harmonic motions of equal period and amplitude in any difference of phase, to form a circular motion. In each case the motion is communicated to a stylus by a link-gear, operated by two wheels rotating in opposite directions. In the first apparatus, the wheels are pivoted about their centres, and the link-gear is pinned to one point on the flat surface of each wheel, near the circumference; in the second apparatus, the wheels rotate as eccentrics at 180° to one another, and the motion to the link-gear is communicated by thrust-rods, held by springs against the peripheries of the corresponding wheels. Dr. Thompson further exhibited a device for projecting, by lantern, the rotating magnet and copper disc, of Arago. The curious rotations and lateral movements of iron-filings, in a revolving magnetic field, were similarly projected on a screen. He also showed some experiments with a heat-indicating paint, made from a double iodide of copper and mercury, discovered twenty years ago by a German physicist. At ordinary temperatures the paint is red, but at 97° C. it turns black. If paper is covered with this substance, and then warmed at a stove, the change is effected in a few seconds. Various designs can be wrought upon the back of the paper in dead-black or gold, so that when warmed they appear in red or black on the front, according to their respective absorptive powers. Or local cooling by the hand will yield a silhouette. If the paper is allowed to cool, the silhouette vanishes, but it appears again when the paper is reheated. It has thus a kind of thermal "memory." A yellow double iodide of silver and mercury is even more sensitive. It changes from yellow to dark red at 45° C. Lastly, Dr. Thompson exhibited a kinematic model of Hertz-wave transmission. A row of lead bullets is suspended from strings, so that the bullets hang clear of one another by about an inch, in a right line. The strings are meshed, and herein the model differs from the well-known wave-models used in acoustics. If the attempt is made to send an acoustic form of wave through the system, by giving an impulse to the first bullet in the plane of the other pendulums, it fails immediately, owing to the slackening of parts of the meshes. Thus, only *transverse* vibrations can be transmitted. To illustrate the propagation of a Hertz-wave, a heavy pendulum, oscillating in a plane at right-angles to the line of bullets at one end, represents the Hertz "oscillator." A metal ring, mounted horizontally on a trifilar suspension, and properly "tuned," represents, at the distant end, the Hertz "resonator." Waves, formed by the transverse vibrations of successive bullets, are then propagated from end to end. Prof. Fitzgerald said the model was specially interesting as illustrating the difference in velocities of propagation of a given wave, and of the energy corresponding to it. The model did not accurately compare with ether, because in ether the rate at which the energy is propagated is the same as that of the wave. The difference of the two rates, for any medium, depended upon the "dispersion" of the medium. By slight alteration of the pendulum-suspensions this dispersion might be made different at different parts of the model, and would then correspond to certain known cases of "anomalous dispersion." Or, again, it might be made to illustrate the theory of Helmholtz with regard to the vibrations of the molecules of glass; according to which, the vibration of the molecules alters the vibrations of the waves, so that dispersion occurs, and the energy is not propagated at the same rate as the waves themselves. It was shown by Michaelson that it was possible to have a medium in which the energy is propagated in one direction, and the wave in another. This was attained, in a magnetic model, by Ewing. The mesh apparatus indicated how a model could be made which should give out "harmonics" and "over-tones" very different from one another; where different wave-lengths would be propagated with different velocities, and the over-tones would correspond to the differences. Further, it indicated a mechanism for producing any desired spectrum; such, for instance, as that of hydrogen. A somewhat similar model had been designed by Glazebrook for illustrating the absorption-bands of a medium when the rate of vibration was the same as the free period of the vibrations of each of the molecules, which is the theory of Helmholtz, but it was not such a simple model. The experiment of red paper changing to black was interesting as illustrating a red spectrum varying with temperature.—Mr. Shelford Bidwell proposed votes of thanks to all the exhibitors, and the Society adjourned until April 9.

Chemical Society, March 18.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—On the atomic weight of carbon, by A. Scott. The author calls attention to the unsatisfactory nature of the experimental evidence on which the determinations of the atomic weight of carbon rest; erroneous determinations of the expansion produced by the absorption of carbon dioxide by potash solutions have been employed. When this and other sources of error have been allowed for, the recalculated values of the atomic weight of carbon are 12·008 from the combustion of carbon and 12·050 from the conversion of the monoxide into the dioxide.—On a new series of mixed sulphates of the vitriol group, by A. Scott. The author obtains members of a new series of mixed sulphates of the composition $(MN)''SO_4,H_2O$ by adding sulphuric acid to solutions of the mixed sulphates; the ferrous cupric salt $Cu_2Fe_5(SO_4)_7, 7H_2O$ is reddish-brown in colour.—A synthesis of camphoronic acid, by W. H. Perkin, jun., and J. F. Thorpe. Ethylic β-hydroxy-ααβ-trimethylglutarate is converted by the usual methods into ethylic β-cyano-ααβ-trimethylglutarate, $COOEt.CMe_2.CMe(CN).CH_2.COOEt$; this on hydrolysis yields ααβ-trimethyltricarballylic acid, $COOH.CH_2.C(COOH)Me.CMe_2.COOH$, which is found to be identical with camphoronic acid.—Note on a method of determining melting points, by E. H. Cook.—Velocity of urea formation in aqueous alcohol, by J. Walker and S. A. Kay. The addition of ethylic alcohol to an aqueous solution of ammonium cyanate undergoing conversion into urea accelerates the reaction; if the reverse action and the degree of dissociation at the various stages of the process are taken into consideration, it is found that the law of mass-action is strictly obeyed. The authors calculate that the conversion of ammonium and cyanate ions into urea is accompanied by a heat evolution of about 5000 cals. per gram-molecule.—Action of alkyl haloids on aldoximes and ketoximes, by W. R. Dunstan and E. Goulding. When formaldoxime, acetaldoxime, and acetoxime are heated with an alkyl iodide or bromide in alcoholic solution, compounds of the types $R'CHN(R')O$ and $R'_2CNCH(R')O$ are obtained.

Entomological Society, March 17.—Mr. Roland Trimen, F.R.S., President, in the chair.—Mr. Butterfield, present as a visitor, exhibited a series of thirty-three male and six female *Phigalia pedaria*, taken near Bradford, Yorkshire, on February 14-17, 1897. Twenty-one males were typical in having a greater or less development of the four transverse bars. The remaining twelve were without bands, and varied in colour from black to smoky olive; they were decidedly less in point of size, ranging from $1\frac{5}{12}$ in. to $1\frac{7}{12}$ in., as against $1\frac{7}{12}$ in. to $1\frac{11}{12}$ in. in the banded forms, and were also poorer in scales and slightly deformed. He had only met with this variety once before in the last twenty years, and suggested that the eruption of small, black, and depauperised forms might have been produced by dryness and want of food in the larval conditions, the trees having been extensively defoliated in the preceding year.—Mr. Kirkaldy exhibited an example of the rare macropterous form of *Velia currens*, Fabr., taken at East Grinstead, and one of *Cicadetta montana*, Scop., from Brockenhurst.—Mr. Burr exhibited a series of grasshoppers with red and blue hind wings, of the family Œdipodidæ, to show the remarkable variation in colour seen in this group. Red, blue, and yellow forms are found alike in the same species, the blue being due to the failure of the red pigment, and therefore an incipient albinism, the yellow being a further form of albinism.—Mr. Champion communicated a paper on the Elateridæ and Rhipidoceridæ collected by Mr. H. H. Smith at St. Vincent, Grenada, and the Grenadines, and exhibited the specimens.—Dr. Forel also communicated a paper on the Formicidæ collected by Mr. Smith in the same islands.

Linnean Society, March 18.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. Bernard Arnold exhibited three contiguously-built nests of the chimney swallow, *Hirundo rustica*, having a continuous wall of mud as if built by one pair of birds; but from the evidence of the observer it appeared that there were two pairs of birds, and that one pair had made two of the adjacent nests.—The Right Hon. Sir John Lubbock, Bart., F.R.S., read a paper on stipules, their forms and functions. This embodied observations supplementary to those published in previous papers (*Linn. Soc. Journ.*, *Bot.* xxviii. 217, and xxx. 463). It was shown that while the usual function of stipules is to protect leaves in bud, in some cases they replace them, and in others serve to hold water. Instances were mentioned in which stipules developed into spines, and in other cases became glandular. Where stipules were absent, other arrangements for bud protection were found to exist. Attention was especially directed to the formation of the winter buds of certain common shrubs and trees, and some curious differences were noted even in nearly allied species. In the wayfaring-tree, *Viburnum Lantana*, the author remarked that the young leaves are uncovered, but are protected by a growth of hairs; in the ash and thorn the outer scales of the bud consist of expanded petioles; in the willow the outer scales consist of leaves; in the poplar of stipules. The buds of the oak and beech were also described; and it was shown by the aid of lantern-slides that in the beech the outer scales of the bud consist of two pairs of stipules, that the twelfth pair are the first which have a leaf, and that the subsequent growth is between the leaves, while the portion of the shoot between the stipules scarcely elongates at all. As a consequence the seat of each winter bud is marked by a ring, and thus a series of successive rings which remain visible for many years indicate each year's growth.—Mr. W. C. Worsdell read a paper on the origin of transfusion-tissue in leaves of gymnospermous plants. It was explained that "transfusion-tissue" is a special kind of conducting-tissue found chiefly in the leaves of conifers, in direct connection with the vascular bundles. Evidence was adduced in favour of the conclusion that transfusion-tissue, as universally found in recent coniferous leaves, has originally sprung from the centripetal xylem of the leaf-bundle of the ancestors of these plants.

CAMBRIDGE.

Philosophical Society, March 8.—Mr. F. Darwin, President, in the chair.—On the injection of the intercellular spaces occurring in the leaves of *Elodea* during recovery from plasmolysis, by the President and Miss D. F. M. Pertz. *Elodea* continues to assimilate in salt solutions strong enough to plasmolyse the cells. On replacing the plant in water assimilation ceases, the gas disappears from the intercellular spaces, and the leaf is injected with water. The disappearance takes place partly by the escape of bubbles at the open ends of the intercellular spaces, but chiefly by solution. The first of these phenomena depends on the surface tension of salt solutions being greater than that of water. The solution depends on the fact that air is less soluble in salt solutions than in water.—The phenomena of carbon dioxide production associated with reduced vitality in plants, by Mr. F. F. Blackman. By the aid of an apparatus (which was exhibited), specially adapted for physiological research on very small outputs of carbon dioxide, several new phenomena of this nature have been brought to light in plants. These comprise the liberation of carbon dioxide produced in the following four cases. Firstly, that resulting from the action of temperatures between 40° C. and 50° C. on dry resting seeds: at temperatures below 40° C. no appreciable formation of carbon dioxide takes place, and at continued higher temperatures the amount, which is at first large, does not remain so but steadily falls off, indicating the decomposition of a definite limited quantity of some substance. Secondly, the large amount of carbon dioxide produced in the first few hours after wetting coarsely-ground dry seeds. This cannot be attributed to the action of micro-organisms, and is hindered by the action of chloroform and other poisons. Thirdly, the varying production of carbon dioxide by the action of volatile poisons and of fatal temperatures on living leaves. Finally, the post-mortem production of carbon dioxide brought about by subjecting recently-killed leaves to the action of a temperature of 100° C. This amount was shown to vary with the method of killing adopted, and evidence was forthcoming to show that in this, as in the other cases, those substances which easily oxidise with liberation of carbon dioxide are in some way to be associated with normal respiratory processes.—On the leaves of *Bennettites*, by A. C. Seward. In this paper the author described some specimens of *Williamsonia gigas* Carr. and *Zamites gigas* L. and H., from the Jurassic rocks of the Yorkshire coast, and now in the Natural History Museum, Paris. In recent years it has been customary to discredit or entirely deny the correctness of the earlier views as to the generic identity of *Zamites gigas* and *Williamsonia*. A recent examination of the specimens in the Paris Museum convinced the author that *Williamsonia* is the inflorescence of *Zamites gigas*. The conclusions now arrived at enable a Bennettitean inflorescence to be connected with a definite form of fronds.

PARIS.

Academy of Sciences, March 22.—M. A. Chatin in the chair.—The President announced to the Academy the loss it had sustained by the death of M. Antoine d'Abbadie, Member of the Section of Geography and Navigation.—On the Phanerogams without seeds, forming the division of the Inseminеæ, by M. Ph. van Tieghem. An outline of a new classification of the Phanerogams.—On the mechanical work performed by muscles, by M. A. Chauveau. An extension of a preceding paper, giving details of experiments with isolated fresh muscles from frogs. The muscle was weighted with different loads, stimulated with a rapidly alternating current, and the heating effects produced measured with a thermo-electric couple.—On an angular multi-divider, by M. Guillerminet.—On an electric commutator capable of being adjusted from a distance, by M. C. Gros.—On the perihelia of the planets, by M. Delauney.—On autoradioscopy, by M. Foveau de Courmelle.—On the geometry of the triangle, by M. Labergère.—On the successive differentials of a function of several variables, by M. Moutard.—On the determination of the group of transformations of a linear differential equation, by M. F. Marotte.—On the latent heats of evaporation and the law of Van der Waals, by M. Georges Darzens. The author has shown in a preceding note that the Van der Waals equation $M\lambda/T_c = f(T/T_c)$ (where M is the molecular weight, λ the latent heat of vaporisation at the absolute temperature T, and T_c the absolute critical temperature) may be put in the form $M\lambda/T = F(T/T_c)$, where the first term is independent of the critical temperature. The exactness of the law of corresponding states may be indirectly verified by plotting on squared paper the values of $M\lambda/T$ as ordinates against T/T_c as abscissæ, and seeing if the resulting points, either for one substance at different temperatures, or for different substances, lie on a continuous curve. It was found necessary to divide the substances taken into groups in order to get the points to lie on a curve. Thus benzene, chloroform, carbon tetrachloride, sulphur dioxide, nitrous oxide, and carbon dioxide form one group; water, acetone, and ether form another.—Stereoscopy of precision applied to radiography, by MM. T. Marie and H. Ribaut. The theoretical development of the subject is first given, and then measurements from a series of experiments bearing out the results of the preceding analysis.—The action of nickel upon ethylene, by MM. Paul Sabatier and J. B. Senderens. The nickel used in these experiments was reduced by hydrogen from the oxide at as low a temperature as possible; as it was found that this metal gave the most rapid reaction. The property of acting upon ethylene, however, is not lost even if the nickel oxide is reduced at a red heat. The reaction between the nickel and the ethylene takes place at about 300°; and the main reaction appears to be according to the equation $C_2H_4 = C + CH_4$, although hydrogen is also produced by what is apparently a secondary reaction, the amount increasing with the temperature of the nickel. No such phenomenon occurs when the nickel is replaced by copper, cobalt, iron, or by platinum or palladium black.—Researches on the monazite sands, by MM. G. Urbain and E. Budischovsky. The hydrated earths were treated with acetylacetone, and the resulting acetylacetonates fractionally recrystallised from alcohol and benzene. The lowest atomic weight obtained from the fractions was 95, the highest 112.—A reaction of carbon monoxide, by M. A. Mermet. A solution of potassium permanganate, acidified with nitric acid, and containing silver nitrate, is decolorised by carbon monoxide. With air containing ·002 to ·0002 of its volume of carbon monoxide, the decolorisation was complete in from one to twenty-four hours. Upon this reaction is based the determination of small quantities of CO in rooms.—On isolauronolic acid, by M. G. Blanc. Isolauronyl chloride, treated with zinc methyl in ethereal solution, yields an isomer of camphor, of which the oxime, semicarbazone, hydrazone, and reduction products are described.—On a new method of storing acetylene, by MM. Georges Claude and Albert Hess. It has been found that acetone is a good solvent for acetylene, one kilogram of acetone dissolving 300 litres of acetylene under a pressure of 12 atmospheres.—On the mineralogical constitution of the island of Polycandros, by M. A. Lacroix. The south-eastern portion of the island consists of white or greyish-white limestone deposits, the remainder consisting of mica and chlorite schists.—On the part played by phenomena of superficial alteration in metalliferous strata, by M. L. de Launay.—On the gradual loss of lime in basic eruptive rocks of the region of the Pelvoux, by M. P. Termier.—Work carried out by the Geographical Service of the Expeditionary Corps of Madagascar, during the campaign of 1895, by M. R. Bourgeois.—The movement of lunar rotation, by M. D. A. Casalonga.—On an apparatus called a kineometer, by M. Aug. Coret.—The problem of aviation, by M. Th. Colombier.

AMSTERDAM.

Royal Academy of Sciences, January 30.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Engelmann, referring to experiments made by Dr. Woltering and himself at Utrecht, treated of the rate at which stimuli of various intensity are propagated through muscular fibres.—Prof. van Bemmelen made a communication concerning the chemical metamorphosis of phosphate in fossil bones.—Prof. van der Waals described an inquiry made by himself, in accordance with the molecular theory of a mixture developed by the author (*Arch. Neerl.*, t. xxiv.), into the extent to which the complexity of the molecules of a solvent may influence the magnitude of the decrease of vapour-tension by dissolved salts. He arrived at the conclusion that the decrease of vapour-tension is determined solely by the magnitude of the molecules of the solvent when in the state of vapour.—Prof. Engelmann presented, on behalf of Mr. E. G. A. ten Siethoff, of Deventer, a paper entitled "An explanation of the optical phenomenon in the eye, discovered by Dr. P. Zeeman." Dr. Zeeman described (Report of the meeting of the Physical Section of the Royal Acad. of Sc., February 25, 1893; NATURE, vol. xlvii., 1893, p. 504; and *Zeitschr. f. Psych. und Phys. d. Sinnesorg*, vol. vi., 1894, p. 233-234) a subjective optical phenomenon, which occurs when a slit, brightly illumined, preferably by monochromatic yellow light, is observed in the dark. Then a bluish-violet line of light is seen, curved like the outline of a pear, whose axis stands perpendicularly upon the middle of the slit. When regarded with the right eye, the point of the light figure is turned to the right (to the left when seen with the left eye), and the rounded side slightly overlaps the illumined slit. The observation of the phenomenon is easiest with yellow or white light; still, Dr. Zeeman succeeded in observing it when using any of the three hydrogen lines. The subjective optical phenomenon observed by Dr. Zeeman ought, in the author's opinion, to be conceived as an entoptical, complementary after-image of the macula lutea and its surroundings, caused by the percipient elements posterior to it being stimulated. This after-image is violet-coloured with any kind of light, because in the place indicated yellow light always prevails, in consequence of the elective absorption of the yellow pigment.—Prof. Kamerlingh Onnes read a letter from Mr. Edm. van Aubel, of Brussels, concerning the experiments of Dr. Zeeman, mentioned at a previous meeting, "On the influence of magnetism on the nature of the light emitted by a substance."

DIARY OF SOCIETIES.

THURSDAY, April 1.

Royal Society, at 4.30.—The Croonian Lecture—"The Mammalian Spinal Cord as an Organ of Reflex Action"—will be delivered by Prof. C. S. Sherrington, F.R.S.
Royal Institution, at 3.—The Relation of Geology to History: Prof. W. Boyd Dawkins, F.R.S.
Society of Arts, at 4.30.—A Visit to Russian Central Asia: Michael Francis O'Dwyer.
Linnean Society, at 8.—On the Evolution of Oxygen from Coloured Bacteria: Dr. A. J. Ewart.—On the Germination of Spores of Agaricineæ: Miss Helen Beatrix Potter.
Chemical Society, at 8.—On the Oxidation of $\alpha\gamma$-Dimethyl-a'-Chloropyridine: E. Aston and Prof. J. Norman Collie, F.R.S.—The Composition of Cooked Fish: K. J. Williams.
Camera Club, at 8.15.—Mountain and West Coast Scenery at Home and Abroad: T. C. Porter.

FRIDAY, April 2.

Royal Institution, at 9.—Metallic Alloys and the Theory of Solution: Charles T. Heycock, F.R.S.
Geologists' Association, at 8.—The Physical History of Romney Marsh: George Dowker.—A Collection of Flint Implements from Cookham: Llewellyn Treacher.

SATURDAY, April 3.

Royal Institution, at 3.—Electricity and Electrical Vibrations: Lord Rayleigh, F.R.S.
Geologists' Association (Baker Street Station), at 1.37.—Excursion to Chesham and Cowcroft. Director: Upfield Green.

MONDAY, April 5.

Society of Arts, at 4.30.—Alloys: Prof. W. C. Roberts-Austen, C.B., F.R.S.
Sanitary Institute, at 8.—Sanitary Building Construction: Prof. T. Roger Smith.
Society of Chemical Industry, at 8.—Election of Officers and Five Members of Committee for the Session 1897–98.—The Chemical Stability of Nitro-compound Explosives: Oscar Guttmann.
Victoria Institute, at 4.30.—Australian Aboriginal Art: The Bishop of Ballarat.

TUESDAY, April 6.

Royal Institution, at 3.—Animal Electricity: Prof. A. D. Waller, F.R.S.
Society of Arts, at 8.—Recent Travels in Rhodesia and British Bechuanaland: C. E. Fripp.
Zoological Society, at 8.30.—On the Myology of the Terrestrial Carnivora: Drs. B. C. A. Windle and F. G. Parsons.—Note upon the Minute Structure of the Teeth of *Notoryctes*: C. S. Tomes, F.R.S.—On the Blue Bear of Tibet, with Notes on the Members of the *Ursus arctus* Group: R. Lydekker, F.R.S.—An Account of the Freshwater Fishes collected in Celebes by Drs. P. and F. Sarasin: G. A. Boulenger, F.R.S.
Institution of Civil Engineers, at 8.—Paper to be further discussed: Electric Lifts and Cranes: Henry W. Ravenshaw.——Paper to be read, time permitting: The Blackwall Tunnel: David Hay and Maurice Fitzmaurice.—Ballot for Members.
Mineralogical Society, at 8.—On a New Occurrence of Apophyllite in South Africa: J. Henderson.—On a Mineral from Hungary: Messrs. Prior and Spencer.—On the Indexing of Mineralogical Literature: Prof. Miers.—Some Simple Names for the Thirty-two Types of Crystal Symmetry: Prof. Miers.
Royal Victoria Hall, at 8.30.—Movements of Plants: Rev. George Henslow.

WEDNESDAY, April 7.

Society of Arts, at 8.—Dairy Produce and Milk Supply: M. J. Dunstan.
Geological Society, at 8.—On the Morte Slates and Associated Beds in North Devon and West Somerset, Part II.: Dr. Henry Hicks, F.R.S.—The Glacio-Marine Drift of the Vale of Clwyd: T. Mellard Reade.
Entomological Society, at 8.—Report of the Committee on the Protection of British Insects in danger of Extermination.
Sanitary Institute, at 8.—Notification of Measles: Dr. Henry R. Kenwood.
Society of Public Analysts, at 8.—The Separation and Identification of the Typhoid and Colon Bacilli: F. Wallis Stoddart.—Notes on Alcohol: J. F. Liverseege.
Institution of Naval Architects, at 12.—Annual Report of Council, Election of President, Officers, and Council.—Address by the Chairman, the Right Hon. the Earl of Hopetoun, G.C.M.G.—The following Papers will then be read and discussed:—Recent Trials of the Cruisers *Powerful* and *Terrible*: A. J. Durston, C.B., R.N.—Water Tube Boilers in Warships: Rear-Admiral C. C. P. Fitzgerald, R.N.—A Mechanical Method of ascertaining the Stability of Ships: A. G. Ramage.

THURSDAY, April 8.

Royal Society, at 4.30.—*Probable* Papers: The Production of X-rays of different Penetrative Values: A. A. C. Swinton.—On the Application of Harmonic Analysis to the Dynamical Theory of the Tides, Part I.: S. S. Hough.—Photographic Spectra of Stars to the 3½ Magnitude: F. McClean, F.R.S.—(1) Double (Antidrome) Conduction in the Central Nervous System; (2) Further Note on the Sensory Nerves of Muscles: Prof. Sherrington, F.R.S.—On the Breaking-up of Fat in the Alimentary Canal under Normal Circumstances and in the Absence of the Pancreas: Prof. V. Harley.—Condensation of Water Vapour in the Presence of Dust-free Air and other Gases: C. T. R. Wilson.—On Boomerangs: G. T. Walker.
Royal Institution, at 3.—Roman Britain: Prof. W. Boyd Dawkins, F.R.S.
Mathematical Society, at 8.—On the Potentials of Rings: A. L. Dixon.—An Extension of a certain Theorem: Rev. F. H. Jackson.
Institution of Electrical Engineers, at 8.—Recent Developments in Electric Traction Appliances: H. A. Baylor.
Institution of Naval Architects, at 12.—On the Fighting Value of certain of the Older Ironclads if re-armed: Captain the Right Hon. Lord Charles Beresford, C.B., R.N.—The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion: Hon. Charles Parsons.—On the Use of the Mean Water-Line in designing the Lines of Ships: A. G. Ramage.——At 7.—The Accelerity Diagram of the Steam-Engine: J. Macfarlane Gray.—Note on the Geometry of Stability: J. Macfarlane Gray.—Acetylene, and its Probable Future Afloat: Prof. Vivian B. Lewes.
Camera Club, at 8.15.—The Phonograph: Mr. Stroh and F. C. B. Cole.

FRIDAY, April 9

Royal Institution, at 9.—The Limits of Audition: Lord Rayleigh, F.R.S.
Physical Society, at 5.—A Nickel Stress Telephone: T. A. Garrett and W. Lucas.—On Alternating Currents in Concentric Conductors: W. A. Price.—On the Effect of Capacity on Stationary Electrical Waves in Wires: W. B. Morton.
Royal Astronomical Society, at 8.
Institution of Civil Engineers, at 8.—Poole Harbour: Harold Berridge.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—First Stage Inorganic Chemistry: Dr. G. H. Bailey (Clive).—Statesman's Year Book, 1897 (Macmillan).—Algebra for Beginners: Dr. I. Todhunter, revised and enlarged by Prof. S. L. Loney (Macmillan).—Hydraulic Machinery: R. G. Blaine (Spon).—Bourne's Insurance Directory, 1897: W. Schooling (E. Wilson).—Report of Observations of Injurious Insects: E. A. Ormerod, 20th Report (Simpkin).—Who's Who, 1897 (Black).—Les Femmes dans la Science: A. Rebière, deux édition (Paris, Nony).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part 3 (Edinburgh, Douglas).—First Principles of Natural Philosophy: Prof. A. E. Dolbear (Boston, Mass., Ginn).—Natural History in Shakespeare's Time: H. W. Seager (Stock).—Recherches sur la Sève Ascendante: H. S. Chamberlain (Neuchatel, Attinger).—Ueber den Bau der Korallenriffe: Dr. A. Krämer (Kiel, Lipsius).—Congrès International des Pêches Maritimes, September 1896, Comptes rendus des Séances (Paris).—A Guide to the Clinical Examination of the Blood for Diagnostic Purposes: Dr. R. C. Cabot (Longmans).

Pamphlets.—On the Colour and Colour-Patterns of Moths and Butterflies: A. G. Mayer (Boston, Mass.)—Some Factors in the Evolution of Adaptations: J. D. Haviland (Porter).—Birds of the Galapagos Archipelago: R. Ridgway (Washington).

Serials.—Longman's Magazine, April (Longmans).—Good Words, April (Isbister).—Sunday Magazine, April (Isbister).—Chambers's Journal, April (Chambers).—Reliquary, &c., April (Bemrose)—Journal of the Chemical Society, February (Gurney).—Economic Journal, March (Macmillan).—Century Magazine, April (Macmillan).—Zeitschrift für Criminal-Anthropologie, Band 1, Heft 1 (Berlin, Priber).—Himmel und Erde, Marz (Berlin, Paetel).

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