THURSDAY, JUNE 9, 1892.

A PROFESSORIAL UNIVERSITY OF LONDON.

THE recent history of the London University question affords decisive proof that the new University, which is to be the outcome of the labours of the Royal Commission now sitting, must be much more than a merely exclusive or merely local institution. Of the two main objects of a University in any English sense of the expression—the promotion of the higher education, and the advancement of learning—both must be equally subserved; and neither will be attained if the new University be established on other than the broadest possible basis, or if its development be controlled and hindered by rivalries that could not but become of an ignoble character. In the course of discussion it has been made abundantly clear that a duplication of Universities in London would be a misfortune of the first magnitude, dividing resources and diverting energies into channels that would lead to many undesirable results. It is equally clear that a University, consisting of a federation of local educational institutions existing within the same narrow area, would be wanting both in unity and force: its government would tend to become a succession of compromises effected between the interests, almost wholly of a financial nature, of its constituent Colleges. It may, then, be taken as a conclusion accepted by the great majority of those who have given special attention to the subject that there should be one University, and one only, in London, and that it should not be of a federal character. To this position it is a simple corollary that the government of the proposed University should be vested mainly in a professorial body. Much the most important work of the University would be the enactment of curricula and syllabuses and the control of teaching and examination—work that can only be efficiently performed by those specially familiar with the subjects taught. With the Professors a proper number of Crown nominees should be associated to act as moderators and as representatives of general educational policy, as well as to guard the interests and assure the continued confidence of the public. With the mode of creation and with the functions of the usual Faculties, and with the details of examinational systems, we need not at present concern ourselves. In fact, the less the new University is fettered by any Charter or Act the better, and it would be a misfortune were the precedent followed of the complicated and minutely detailed Charter recently rejected by the Convocation of the London University. On that occasion, it must be admitted, Convocation made good use of its veto, but its continued possession of such a power would, we think, be a source of disquiet and danger, without any corresponding advantage to Convocation itself, or the University—especially a professorial University—or indeed to the public. A much more useful provision would be the grant of a power of appeal to some such Committee of the Privy Council as that by whose aid the Scotch Universities are enabled to settle their differences.

The possibility of any such University as we have indicated above ever coming into existence—and for a University of any other kind it is scarcely worth while to exert oneself—depends largely on the good will of the existing Colleges. They must follow the capital example set by Bedford College, and signify their willingness to be merged in and become part of a true London University with such reservations in respect of particular portions of their collegiate work as may be necessary. As far as the professorial staffs of these Colleges are concerned, there can be little doubt but that they would hail such an event; but it is possible that the governing bodies may take a different view. And with regard to the Medical Schools, the reservations touching their purely professional work, must, from the nature of the case, be extensive.

Though, for the moment, the question of a new University is chiefly interesting from the point of view of science and medicine, what for the sake of brevity may be termed the arts aspect of the question must not be neglected. There are very few science students who do not follow—and follow of necessity—special courses of instruction in fairly equipped laboratories; but the arts student is less constrained in his mode and course of study—he has, indeed, in London less opportunity of benefiting by adequate instruction in the subjects of his studies. The stimulus to every form of education that the new University may be expected to give will supply this deficiency; but meanwhile, and probably to a greater or less extent always, the case of the "private student' in arts will have to be considered. We shall not enter upon it here. Our object in mentioning the case of the arts student is rather to show that the interests of the two great divisions of human knowledge are at one in the matter of the proposed University. It may be added that the "private student" difficulty, so far as it exists, should be left to be dealt with by the new University. It is limited in character, though extensive in scope, and is very far indeed from being insurmountable.

To resume. We are entirely in favour of a single non-exclusive London University, mainly, or at least adequately, of a professorial character—which by no means necessarily involves the extreme teacher-examiner system—controlling both teaching and examination, and being or becoming, by absorption or otherwise, homogeneous in interest, and in the highest degree authoritative in function. All these features are entirely novel; they are not, we believe, possessed by any British University. And herein lies the practical difficulty now to be confronted. The present opportunity for creating such a University is not likely to recur, at all events for some generations to come. What is to be done to make the best of it? The Royal Commission is fully aware of the greatness of the task committed to it, and has entered upon its labours in no niggard, narrow, or unappreciative spirit. But the Commission must be aided by educational opinion clearly thought out and firmly expressed. It must have the support of the London University, of the great Colleges, of the Medical Schools, and of the professorial body in London, who should be aided by the sympathy of their brethren in the provinces—a sympathy, there is good reason to believe, that will not be wanting. Such professorial opinion will include that of the staffs of the Colleges and Schools, and of those members at least of the Senate and Convocation of the University of London who are or have been engaged in professorial work. So powerful a body of opinion cannot but exert a great—indeed, a decisive—influence upon what may be termed the lay elements of the governing bodies, whom we can only reach through their professorial colleagues.

It is difficult to see how the arguments of eminent specialists in support of the general arguments called forth by the occasion can be rejected, when once the novelty of their proposals has been got over. Convocation, with an appeal to the Privy Council, will have a far more usable and useful power than is inherent in the bare obstructiveness or quasi-terrorism of the veto. The Senate in Burlington Gardens will scarcely refuse to complete the University character of the great institution it governs, and perfect its educational machinery, by placing the responsible direction of the higher education of all its students, without exception or distinction, in the hands of the most eminent representatives of those who have made such education the business of their lives. The Medical Schools will only give up the teaching they are least adapted to furnish, and in lieu of being scattered entities, will become integral portions of a great whole. The private arts student will retain every advantage and privilege he possesses, and cannot but gain by working under syllabuses prepared by past masters in the art of teaching.

Perhaps the best procedure to be adopted by the Professoriate, with whom the initiation of any active propaganda must lie, will be to lay their views before the governing bodies by deputation, and before the Commission by the individual testimony of such among them as may be invited to give evidence on the question. Here a word of caution may not be out of place. Details of a ministerial nature should be avoided as much as possible, for until the main lines of any scheme are settled, it is difficult to say what details are possible or necessary. It is still more important to shun any approach to doctrinairism, the besetting vice of professordom, and treat every principle as modifiable by the circumstances of history, national habit, and environment.

On the financial aspect of the question we can say little. The establishment of a new University will cost money, but no great sum will be needed to start with. The University will, of course, be independent, and the necessary expenses will be defrayed in part by an annual Government grant. Among other sources of income, the funds at the disposal of the County Council may perhaps be counted, and with a view to such assistance it might be found advisable that the University should have a commercial and technical, as well as a purely academical side.

But for the moment, what is of most importance is, we repeat, that the London Professoriate should organize itself, formulate its principles of action in the sense above indicated, and use its influence, publicly and privately, to procure their acceptance as far as circumstances may show to be possible.

INDIAN BOTANY.

Annals of the Royal Botanic Garden, Calcutta. Vol. III. (1) The Species of Pedicularis of the Indian Empire and its Frontiers, by D. Prain, M.B., F.R.S.E., Curator of the Herbarium. (2) The Magnoliaceæ of British India, by G. King, M.B., LL.D., F.R.S., C.I.E., Superintendent of the Garden. (3) The Genus Gomphostemma, by D. Prain. (4) The Species of Myristica of British India, by G. King. 4to, pp. 350, tt. 174. (Calcutta: Printed at the Bengal Secretariat Press, 1891.)

THE two previous volumes of this publication are devoted entirely to the illustration and description of the arboreous element in the Indian Flora, and the letter-press is solely the work of Dr. King. Volume I. deals with the difficult genus *Ficus*, illustrated by 232 plates; and the second volume treats of the almost equally difficult genus *Quercus* and the allied *Castanopsis*, as well as the genus *Artocarpus*, of which seventeen species are described and figured. As may be seen from the list of papers given above, the work in the present volume is partly by Dr. King, and partly by his Curator, Dr. Prain; the former continuing his valuable labours on the trees of India, whilst Dr. Prain has taken up two herbaceous genera. A critical review of this ponderous volume would require more space than could be given to it in the pages of NATURE, and a much deeper knowledge of the subjects than the writer possesses; but it is not a difficult task to give an idea of the nature and quality of the series of monographs it contains. At the outset one is disposed to find fault with the bulk and fourteen pounds weight of this book, because it is really fatiguing to handle, and smaller volumes are in every way more desirable. Fortunately, the present volume may be conveniently bound in three nearly equal parts, as each monograph has its separate title-page and index. Indeed, it might be preferable to bind each of the four monographs separately.

The present volume, it will be perceived, is partly devoted to utilitarian botany, which will be welcome to the forestry department, as well as to botanists generally, and partly to botany of a kind that appeals more especially to the biologist. Dr. Prain's elaborate and painstaking monograph of the genus *Pedicularis* belongs to the latter category, and may be recommended for study to the young aspirant for honours in the same direction as a model of thoroughness, so far as external morphology goes. To persons acquainted only with our two native species of *Pedicularis*, the wide range of modification exhibited in the forms of the corolla is surprising, and reminds one of Prof. Huxley's remark that the genus *Gentiana*, as generally circumscribed, presents nearly as much variation in the shape of the corolla as all the genera of the Gentianaceæ combined. This polymorphism is sufficiently illustrated in the comparatively recent monograph of the whole genus *Pedicularis* by the late Mr. Maximowicz. He figures the flowers of all the species known to him, whilst Dr. Prain figures the plants, or portions of the plants, of all the Indian species, as well as their flowers. Great as is the variety, however, in the size and shape of the corolla in *Pedicularis*, it would be wrong to say that it is nearly as great as in the whole order of the Scrophularineæ. The two principal kinds of variation are the length and the relative diameter of the tubular portion, and the shape of the lips, especially of the upper one, of which there are many curious and even fantastic modifications. Maximowicz's monograph of the whole genus (which is dispersed all round the northern hemisphere, and perhaps extends just over the equator in the Andes) includes about 250 species, and a few have been discovered in India and China since. Prain's monograph of the Indian species contains nearly double the number described in the "Flora of British India" in 1884. The systematic part is preceded by an elaborate and masterly essay on the distribution and descent of the species, illustrated by diagrams and a map. The latter might certainly, with a little extra work, have been made clearer. Dr. Prain divides the genus primarily into three groups—namely, *Longirostres*, *Aduncæ*, and *Erostres*—based on the modifications of the upper lip of the corolla; and the names are sufficiently descriptive to indicate their application. Each of these groups contains both opposite (or verticillate) and alternate leaved species, and is subdivided into a number of sections. So far as we have tried the keys to the sections and species we have found them work admirably, and the descriptions are evidently very carefully written; but twelve to eighteen lines of description in the ablative absolute without a stop or any variation in type is bewildering, and an innovation that is to be deprecated. Dr. Prain himself appears to have realized this, for in his account of *Gomphostemma* his descriptions are shorter and punctuated, with the names of the various organs in italics.

Dr. King's monographs of the Magnoliaceæ and the genus *Myristica* are written entirely in English, perhaps with advantage, because Latin descriptions are not so easily understood as English by many persons interested in trees. Including the suborder Schizandreæ, the number of Indian Magnoliaceæ described and figured is forty-five, referred to eight genera.

Passing on to his monograph of the species of *Myristica* of British India, we find that he distinguishes sixty-eight, illustrated by sixty-nine plates. By British India, Dr. King understands political British India, including the Nicobar and Andaman Islands, and the territories of the Straits Settlements. Dr. King follows Bentham and Hooker, and others, in referring all the nutmegs to the one genus *Myristica*, and, as thus limited, it is represented in nearly all tropical countries. Ten years ago, less than a hundred species were described, but Dr. Warburg, who is at present at Kew engaged on a monograph of the order, estimates the number now in herbaria at about 200. This great augmentation is almost wholly from discoveries in the Malayan Peninsula and Archipelago, New Guinea, and Eastern Polynesia. Dr. King abstains from any attempt to trace the geographical distribution of the species, on the ground that he believes many yet remained to be discovered. But on running through his work we find that about fifty-four of his sixty-eight species are from the Malayan region, eight from the Deccan and Ceylon, and about six from the Assam and Chittagong region, only two apparently being found as far westward as Sikkim, in North India. Most of the new species are from Perak, a country exceedingly rich in endemic trees. Beyond the distribution indicated, there is one species in North Australia, and four each in Madagascar and Tropical Africa, and perhaps about forty or fifty in America, extending from South Brazil through the West Indies and Venezuela to Central America and South Mexico. The author is careful to explain that he does not regard the present effort as anything approaching finality, and anyone acquainted with the genus will understand the difficulties encountered in working from herbarium specimens alone. With one interesting exception (*Myristica canarioides*, King) the species are diœcious, and female flowers are much rarer than males; and the fruit, which affords good characters in a fresh condition, is often wanting, or not in a good state for description. But if Dr. King's work is necessarily incomplete, it supplies the very best materials for the foundation of a more exact knowledge. The figures, although possessing no great artistic merit, are faithful portraits of authentic specimens of the several species, and, combined with the very full descriptions, are sufficient to enable botanists to determine most of the species. On the other hand, the fine work in the analyses of the flowers is indistinctly reproduced in some of the plates, apparently in consequence of their having been drawn on too small a scale. The flowers, it may be added, of many species, are exceedingly small, of some not more than a twentieth of an inch in diameter. But I must draw this notice to a close with the remark that this volume is a monument to the skill and industry of Dr. King and his colleague, and a credit to the native lithographers and printers. One only marvels how the authors, with their multifarious duties, accomplish so much in a tropical climate.

W. BOTTING HEMSLEY.

MATHEMATICAL RECREATIONS AND PROBLEMS.

Mathematical Recreations and Problems of Past and Present Times. By W. W. Rouse Ball. (London: Macmillan and Co., 1892.)

THE idea of writing some such account as that before us must have been present to Mr. Ball's mind when he was collecting the material which he has so skilfully worked up into his "History of Mathematics." We think this because the extent of ground covered by these "Recreations" is commensurate with that of the "History," and many bits of ore which would not suit the earlier work find a fitting niche in this. Howsoever the case may be, we are sure that non-mathematical, as well as mathematical, readers will derive amusement, and, we venture to think, profit withal, from a perusal of it. The author forewarns possible readers that "the conclusions are of no practical use, and most of the results are not new." This is plain language, but, lest the warning should be too effectual, he adds, "At the same time I think I may assert that many of the questions—particularly those in the latter half of the book—are interesting, not a few are associated with the names of distinguished mathematicians, while hitherto several of the memoirs quoted have not been easily accessible to English readers." We have thus stated the author's *pros* and *cons*, and remark that he has gone very exhaustively over the ground, and has left us little opportunity of adding to or correcting what he has thus reproduced from his note-books.

There are two sources to which every writer on the subject of the earlier part must apply, viz. the "Problèmes plaisans et délectables," by C. G. Bachet, Sieur de Meziriac, and Ozanam's "Récréations mathématiques et physiques." These Mr. Ball carefully discusses as to editions and their respective merits.

The work before us is divided into two parts: mathematical recreations and mathematical problems and speculations. The former consists of seven chapters. In the first chapter are collected together numerous problems with numbers, watches, and cards. Some of these last are interesting to the mathematician, and have been discussed in the *Messenger of Mathematics* and the "Reprint from the *Educational Times*." The Middle Ages furnish some curious questions, and an antique problem in *decimation* is associated with the name of Josephus, but these are well-known instances. Bachet's weights problem calls for mention. It finds a place in the author's algebra; the omissions in Bachet's argument, Mr. Ball notes, have been supplied by Major MacMahon (see NATURE, vol. xlii. pp. 113, 114). Mersenne's numbers have been treated recently at some length by Mr. Ball in the *Messenger of Mathematics* (vol. xxi. pp. 34-40); in this account it is stated that $2^{61} - 1 = 2\,305\,843\,009\,213\,693\,951$ is the biggest known prime. Fermat claims some space (cf. NATURE, vol. xviii. pp. 104, 344). Of his so-called *last theorem* (no integral values of x, y, z, can be found to satisfy the equation $x^n + y^n = z^n$, if n is an integer greater than 2) we read:—

"This proposition has acquired extraordinary celebrity from the fact that no general demonstration of it has been given, but there is no reason to doubt that it is true."

It is fitting that we should give Mr. Ball's grounds for this belief.

"Fermat was a mathematician of quite the first rank who had made a special study of the theory of numbers. That subject is in itself one of peculiar interest and elegance, but its conclusions have little practical importance, and since his time it has been discussed by only a few mathematicians, while even of them not many have made it their chief study. This is the explanation of the fact that it took more than a century before some of the simpler results which Fermat had enunciated were proved, and thus it is not surprising that a proof of the theorem which he succeeded in establishing only towards the close of his life should involve great difficulties."

Proofs have been given in the cases of $n = 3, 4, 5, 7, 14$ (cf. pp. 28, 29). Many subjects of interest take up the second chapter, as "Geometrical Fallacies" (every triangle is equilateral, and the whole is equal to a part: this latter we think we have seen in an article by De Morgan); curious "Proofs by Dissection" (cf. *Messenger of Mathematics*, vol. vi. p. 87), there is a printer's error (p. 35, l. 9 up) of $\tan^{-1}\frac{1}{40}$ in place of $\tan^{-1}\frac{1}{46}$; "Colouring Maps" (only four colours necessary to colour a map of a country, divided into districts, in such a way that no two contiguous districts shall be of the same colour), the literature of this problem is brought fully up to date; an account is given of the results of Cayley's "Contour and Slope Lines," and of Clerk Maxwell's "Hills and Dales." Then follow "Statical Games of Position" ("Three in a Row" and "Tesselation," both problems connected with the name of Sylvester); "Dynamical Games of Position" ("Shunting," "Ferry-boat Problems," and numerous counter, pawn, and solitaire problems), and a glance at "Paradromic Rings."

Chapter iii. treats of "Some Mechanical Questions," as "Perpetual Motion," the "Underhand Cut on a Tennis Ball" (*Messenger of Mathematics*, vol. vii.), the "Boomerang," and the "Flight of Birds" (NATURE, 1890-91). In chapter iv. we have a miscellaneous lot, the fifteen puzzle, Chinese rings, the fifteen school-girls problem, and such card problems as Gergonne's pile problem, the mouse-trap, and many others. Chapter v. discusses "Magic Squares," and chapters vi. and vii. are devoted to "Unicursal Problems." These are Euler's problem (more fully discussed by Listing, "Topologie," and Tait), mazes, geometrical trees, the Hamiltonian game, and the knight's path on a chess-board. All these matters are treated lucidly, and with sufficient detail for the ordinary reader, and for others there is ample store of references. There is no chance of catching Mr. Ball tripping in his use of books, and his ready access to mathematical journals can hardly be surpassed, so that we have not come upon any new facts. We may mention, however, in connection with the knight's path, that there is a short article, accompanied by diagrams, on the subject in the *Leisure Hour* (December 20, 1873), by H. Meyer, of the *Hannoverische Anzeiger*.

The second part, in its opening chapter, gives at some length an account of the three classical proplems, viz. the duplication of the cube, the trisection of an angle, and the quadrature of the circle. Chapter ix., on astrology, has many curious details relating to that science, and gives a facsimile of Cardan's drawing of the horoscope of Edward VI., with an abstract of Cardan's account. On the whole matter of the chapter Mr. Ball writes:—

"Though the practice of astrology was connected so often with impudent quackery, yet one ought not to forget that nearly every physician and man of science in mediæval Europe was an astrologer. These observers did not consider that its rules were definitely established, and they laboriously collected much of the astronomical evidence that was to crush their art. Thus, though there never was a time when astrology was not practised by knaves, there was a period of intellectual development when it was accepted honestly as a difficult but real science."

De Morgan, it may be remembered, in the "Budget" (p. 278) says:—

"If anything ever had a fair trial, it was astrology. The idea itself is natural enough. A human being, set down on this earth, without any tradition, would probably suspect that the heavenly bodies had something to do with the guidance of affairs."

"Hyperspace," which occupies chapter x., has a full bibliography (compiled by G. B. Halsted, *American Journal of Mathematics*, vols. i. and ii.), forms the subject of one of Mr. Hinton's interesting "Scientific Romances" (cf. NATURE, vol. xxxi. p. 431), and is connected with Dr. Abbott's "Flatland" (NATURE, vol. xxxi. p. 76). Mr

Ball has made all these the text for a clear account of our present knowledge of higher space. The two last chapters rapidly survey "Time and its Measurement" and "The Constitution of Matter."

Our analysis shows how great an extent of ground is covered by the "Mathematical Recreations," and when we add that the account is fully pervaded by the attractive charm Mr. Ball knows so well how to infuse into what many persons would look upon as a dry subject, we have said all we can to commend it to our readers. The book is most carefully printed (only three or four typographical errors have met our eye, and the figures on pp. 32 and 33 the student will recognize must be drawn incorrectly).

SOILS AND MANURES.

Soils and Manures. By John M. H. Munro, D.Sc. (Lond.) (London: Cassell, 1892.)

THE preface to this book informs us that "it is written for the use of young people in schools and colleges, and those numerous other readers who take an intelligent interest in the how and why of familiar facts and operations, yet have no special training in the language and methods of science."

We must admit that Dr. Munro has succeeded in his endeavour to write a book so simple that it may be put into the hands of a beginner with confidence that he will find few difficulties unexplained, and so trustworthy that the more advanced student may find it helpful and suggestive.

We are having a flood of small agricultural books just now, consequent upon the great movement for technical education in England, but we believe that this book will reach two classes of readers which the majority of other text-books do not seem to have affected. These two classes of readers are farmers and teachers in elementary schools. Too many of these books are written with the idea of preparing students for examination, and they may serve their purpose, but are not very likely to help forward the cause of technical education in agriculture to any considerable extent.

Such education has lately been much talked about, and written about also, and men of authority and experience have even gone so far as to say that the recent attempts to promote it have mostly been failures. But if the means employed have proved inadequate or unsuitable, it does not follow that technical education in agriculture is unnecessary, or that suitable means and methods of promoting it cannot be found.

To attempt to teach the principles of agriculture to men who have no knowledge of either elementary chemistry or botany can scarcely be expected to be generally successful, nor do we hear good accounts of lectures given to farmers by men whose agricultural experience has been mainly limited to the class-room and the laboratory, and who are apt to confound agricultural chemistry with agriculture itself. Yet there are very many earnest workers on the County Councils, who have the cause of agricultural education too much at heart to let a few failures and disappointments dishearten them, and, before very long, we feel sure that they will have more reason for congratulation than at present.

Meanwhile, we can welcome this book of Dr. Munro's and wish it the success it deserves, for not only does the author avoid errors himself but he corrects a few which some other writers of elementary text-books on agriculture have fallen into. Thus, on pp. 20 and 132, he removes the impression which many beginners get (from some "cram-books" we have seen) that silica in a soluble form is very essential as a plant-food, especially to cereals. Only those who are familiar with answers to examination papers in agriculture have any idea how frequently this mistake is made.

The first part of the book, comprising five chapters, will give the reader a very good account of soils, their formation and properties; also of plant-food in the soil, how it is increased, and how rendered available for the use of plants. Included in this first part are two chapters on "Improving the Land" and "Tillage Operations," from the pen of Prof. Wrightson. These fit in well with the rest of the work.

The second part deals with the subject of manures pretty exhaustively, the author giving many illustrations from the Rothamsted experiments. The last chapter, on "Special Manures," gives instructions for valuing artificial manures from the chemical analysis, and we feel sure that the matter dealt with in this chapter will be specially useful, and do at least a little to help the farmer from being defrauded by some few unscrupulous manufacturers, still, unhappily, existent amongst us.

OUR BOOK SHELF.

Catalogue of the Specimens illustrating the Osteology of Vertebrated Animals, Recent and Extinct, contained in the Museum of the Royal College of Surgeons of England. Part III., Class Aves. By R. Bowdler Sharpe, LL.D. (London: Printed for the College and sold by Taylor and Francis, Red Lion Court, Fleet Street, 1891.)

THE first point of interest in looking into this Catalogue was to ascertain which of the innumerable schemes of bird classification had been adopted by the author; we have so many of them nowadays. Sometimes they come upon us two at a time; and to make confusion worse, aged schemes of classification, which one hoped had long ago sunk into a dishonoured grave, are sprung upon us in a fresh edition. The plan followed by Dr. Sharpe is that of Mr. Seebohm, "elaborated in his 'Birds of the Japanese Empire,'" with a few modifications. Under each order is the diagnosis; and there are a few references to the anatomical literature of the subject, which is an addition to the value of the work. These are not very full, but perhaps it is hardly necessary that they should be. A feature of this catalogue is the introduction of illustrations; there are a good many of these—48 in all. They are for the most part figures of the skull, but the syringes of a few birds and the deep plantar tendons of more are also illustrated; two figures illustrate pterylosis, and two more the under surface of the foot. The illustrations in every case are good. The Catalogue is not encumbered with huge lists of synonyms: there is only the most recently accepted name given, together with a few of the most important synonyms. The collection of bones consists of 2380 specimens, representing altogether a little over one thousand species. Some of the fossil forms are of course represented by casts only; but a number of important extinct species, notably among the Dinornithidæ, are well represented by the actual remains, in many instances the types of the species in question. We may point out to the charitably disposed that there are a number of desiderata: there are, for example, no specimens of either the African or the American "Fin-foots."

LETTERS TO THE EDITOR.

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

The Line Spectra of the Elements.

THE proper replies to Prof. Runge's letter in last week's issue of NATURE are three in number: viz. (1) that, as I pointed out in my former letter (NATURE of May 12, p. 29), the reasoning in my paper is valid if, as I there proved and as Prof. Runge now admits in the first sentence of his letter, Fourier's theorem can be applied to motions which approximate to non-periodic motions in any assigned degree and for any assigned time; (2) that I am not aware of anything I have written which countenances Prof. Runge's supposition that "Prof. Stoney has not noticed that a distinct property of the function is wanted in order to get a proper" [rather, a mathematically accurate] "resolution into a sum of circular functions"; and (3) that Prof. Runge is mistaken when he supposes that "the amplitudes and periods" [or frequencies] "of the single terms . . . do not approach definite values when the interval" [*i.e.* the periodic time of the recurrence required by Fourier's theorem] "increases indefinitely."

What the true state of the case is, is most easily shown as regards the frequencies of the lines; and as the proof is, I believe, new, and leads to a result of importance in the interpretation of spectra, I subjoin it.

Take a motion of the electron—

$$x = \text{The sum of partials such as} \left(a \sin \frac{2\pi kt}{j} + b \cos \frac{2\pi kt}{j}\right); \quad (1)$$

with similar expressions for the other two co-ordinates; in which the oscillation-frequencies, the k's, may be commensurable with one another, or incommensurable. If incommensurable, the motion is non-recurrent. Let this motion be arrested at intervals of T, and immediately started afresh as at the beginning. We thus obtain a recurrent motion consisting of a certain section of the motion (1) repeated over and over again. This new motion can be analyzed by Fourier's theorem, and we have to inquire what we thus obtain. Without losing anything in generality, we may confine our attention to the motion parallel to the axis of x, and to the single partial of that motion which is written out above, as all the partials lead to similar results.

Let us then examine by Fourier's method the motion which is represented by the equation—

$$x_k = a \sin \frac{2\pi kt}{j} + b \cos \frac{2\pi kt}{j} \quad . \; . \; . \; . \; . \; (2, a)$$

from $t = 0$ till $t = \text{T}$, and which is repeated from that on at intervals of T. If T is a multiple of j/k, Fourier's theorem simply furnishes equation (2, a) as the complete expression for all time of the motion; so that in this case it indicates the same definite line in the spectrum as is furnished by the original partial of equation (1).

If T is not a multiple of j/k,

$$\text{T will} = (m + \alpha)\frac{j}{k},$$

where m is a whole number and α a proper fraction. Equation (2, a) then becomes

$$x_k = a \sin \frac{2\pi(m + \alpha)t}{\text{T}} + b \cos \frac{2\pi(m + \alpha)t}{\text{T}} \quad . \; . \; (2, b)$$

which is true from $t = 0$ till $t = \text{T}$, after which the motion is to be repeated. Then, by Fourier's theorem—

$$\left.\begin{aligned} x_k = \text{A}_0 + \text{A}_1 \sin \frac{2\pi t}{\text{T}} + \text{A}_2 \sin \frac{4\pi t}{\text{T}} + \; . \; . \; . \\ + \text{B}_1 \sin \frac{2\pi t}{\text{T}} + \text{B}_2 \sin \frac{4\pi t}{\text{T}} + \; . \; . \; . \end{aligned}\right\} (3)$$

is true of this motion for all time, in which

$$\text{A}_n . \int_0^{\text{T}} \sin^2 \frac{2\pi nt}{\text{T}} . dt = a \int_0^{\text{T}} \sin \frac{2\pi(m + \alpha)t}{\text{T}} . \sin \frac{2\pi nt}{\text{T}} . dt$$

$$+ b \int_0^{\text{T}} \cos \frac{2\pi(m + \alpha)t}{\text{T}} . \sin \frac{2\pi nt}{\text{T}} . dt;$$

$$\text{B}_n . \int_0^{\text{T}} \cos^2 \frac{2\pi nt}{\text{T}} . dt = a \int_0^{\text{T}} \sin \frac{2\pi(m + \alpha)t}{\text{T}} . \cos \frac{2\pi nt}{\text{T}} . dt$$

$$+ b \int_0^{\text{T}} \cos \frac{2\pi(m + \alpha)t}{\text{T}} . \cos \frac{2\pi nt}{\text{T}} . dt;$$

which, when integrated, give the following values for A_n and B_n—

$$\left.\begin{aligned} \text{A}_n &= \frac{a \sin 2\pi\alpha - b(1 - \cos 2\pi\alpha)}{2\pi}\left(\frac{1}{d} - \frac{1}{s}\right) \\ \text{B}_n &= \frac{a(1 - \cos 2\pi\alpha) + b \sin 2\pi\alpha}{2\pi}\left(\frac{1}{d} + \frac{1}{s}\right) \end{aligned}\right\} \; . \; . \; . \; (4)$$

where d stands for $(m - n + \alpha)$, and s for $(m + n + \alpha)$.

This furnishes a very remarkable spectrum, a spectrum of lines that are equidistant on a map of oscillation-frequencies, and that extend over the whole spectrum. But they are of very unequal intensities. If T is a long period, m is a high number. The lines are then ruled close to one another, and their intensities are insensible except when n is nearly equal to m, the two brightest lines being the next to the position of the original line of equation (1), one on either side of it, and the others falling off rapidly in brightness in both directions.

If we take a longer period for T, m becomes a still higher number; the lines are more closely ruled and are more suddenly bright up to those on either side of the position of the original line of equation (1), to which also they are now closer; so that, at the limit, when T increases indefinitely, equation (3) becomes a mathematical representation of the original line of equation (1).

This interesting investigation is all the more important as it gives a clue to how rulings of lines which are equidistant and brighter up to the middle may arise; and I feel sure that Prof. Runge will join me in not regretting that he expressed the doubts which led to its solution.

G. JOHNSTONE STONEY.

9 Palmerston Park, Dublin, June 3.

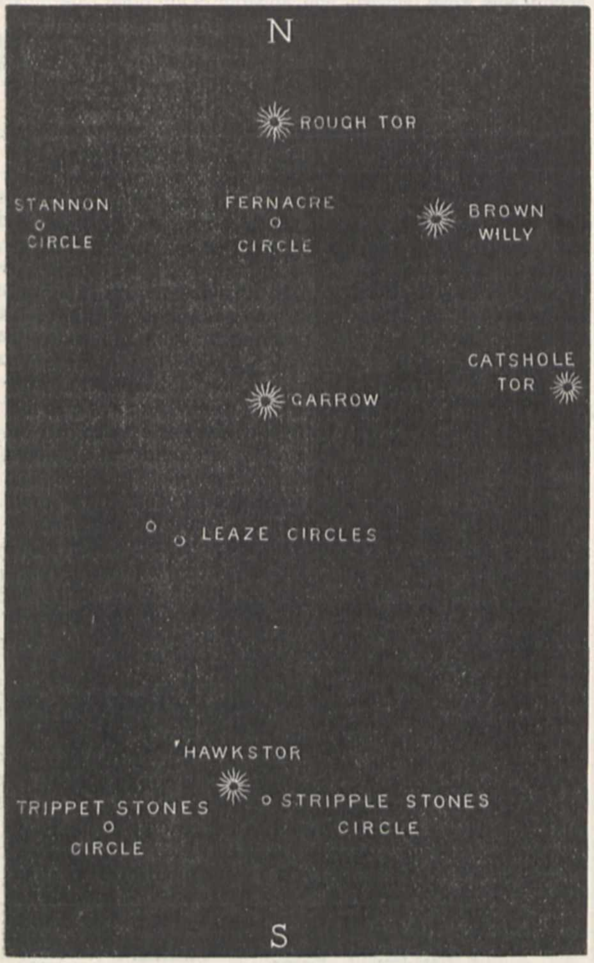
Stone Circles, the Sun, and the Stars.

ARTICLES by Mr. Norman Lockyer and Mr. Penrose, recently published in NATURE, have dealt with the positions of ancient Egyptian and Greek temples with relation to the rising sun, and to the pole star, or some star or stars in its vicinity. For some years past I have endeavoured to show, in papers read before the British Association and other Societies, that our stone circles had a relation to the rising sun, indicated usually by an outlying stone or by a notable hill-top in the direction in which the sunrise would be seen from the circle, and I have in some cases found similar indications towards the north, which may have referred to the pole or other northern star or stars. A paper containing many details as to these cases will shortly appear in the Journal of the Royal Archæological Institute.

There are six circles on Bodmin Moors, which at first sight appear to have no relation to each other, but which, if the 6-inch Ordnance map is to be relied upon, would seem to have been arranged on a definite plan (see accompanying plan).

The Stannon and Fernacre Circles are in line 1° (true) north of east with the highest point of Brown Willy, the highest hill in Cornwall; and the Stripple Stones and Fernacre Circles are in line with the summits of Garrow and Rough Tor, at right angles with the other line—namely, 1° west of (true) north. A line from the Trippet Stones Circle to the summit of Rough Tor would also pass through the centre of one of the Leaze Circles (about 12° east from true north). Other hills are in the direction of the rising sun. The Trippet Stones are $11\frac{1}{2}°$ south of west from the Stripple Stones, 10° east of south from the Stannon Circle, and about 13° west of south from the Fernacre Circle. The respective bearings of the other circles have already been given, and all are true (not magnetic) according to the 6-inch Ordnance map.

More remarkable, perhaps, than the position of these circles are their distances from each other, which, on the level map, are almost exactly as 3, 7½, 2, and 8, for the sides of the irregular four-sided figure, of which four of the circles form the corners, while the diagonals are of the same length within a hundred feet, the differences being much less than the 1 per cent. which Mr. Flinders Petrie has found to be the average error of ancient British and even Assyrian workmanship. The builders of these



circles may be supposed to have aimed in their measurements at even numbers of some unit, and the unit which gives the best results appears to be a Royal Persian or Egyptian cubit of 25·1 inches (not at all the unit one would expect). The actual measurements, as nearly as I can get them from the 6-inch Ordnance map, are:—

	Feet.		Cubits of 25·1 inches.
Stannon Circle to Fernacre Circle ...	6275	=	3000
Fernacre Circle to Stripple Stones ... (Practically 7500 cubits)	15730	=	7520
Stripple Stones to Trippet Stones ... (Practically 2000 cubits)	4180	=	1998·4
Trippet Stones to Stannon Circle ... (Probably meant for 8000 cubits)	16575	=	7924
Diagonals.			
Fernacre Circle to Trippet Stones ...	16950	=	8103
Stannon Circle to Stripple Stones ... (Perhaps meant for 8125 cubits)	16850	=	8055

It must not be forgotten that these measurements are taken from the level map, while the ground between the circles is very irregular, but it seems more probable that the builders of these circles made allowance for the irregularities of the ground than that the distances, as shown by the map, are merely the result of accident.

If, however, the 25·1 inch cubit were the unit of measurement for the distances between the circles, it ought to appear in the measurements of the circles themselves—and it does; for the diameter of the Trippet Stones Circle is exactly fifty of such cubits, and the diameters of the Fernacre and Stripple Stones Circles are (as nearly as I can judge in their ruinous condition) seventy of such cubits.

The Egyptians appear to have constructed separate buildings for the observation of the sun and of the stars, but if the circle builders used the same circles for both purposes, placing them so that when standing in them they could see the sunrise over a fixed point on one hill, and a certain star rise over a fixed point on another hill in another direction, their system was much more economical, though perhaps less exact than that of the more civilized Egyptians.

A. L. LEWIS.

The Height of the Nacreous Cloud of January 30.

THE cloud referred to by Mr. T. W. Backhouse, in your issue of February 18 (p. 365), attracted universal attention over Eastern Yorkshire and even in Lincolnshire, so that numerous letters were sent to the *Leeds Mercury*, *Yorkshire Post*, &c.

Its general appearance in these parts is being dealt with by Mr. H. Bendelack Hewetson, of Leeds. I will therefore merely state that the intensity of the fringes surpassed anything in my previous experience. Even those observed in 1884–85, in connection with the Krakatão glows, did not approach it in this respect.

Here, as it happened, Venus lay just upon its lower edge. As this was fairly horizontal, save for a break not far from the middle, I was very pleased to get from Mr. C. J. Evans, Ackworth, near Pontefract, a second observation. In response to further appeals, observations, of varying accuracy, from the places in the subjoined table, were available for calculating the height.

Leeds (Prof. A. Lupton saw the cloud "nearly overhead," "if not, a little S.S.W.," "within 20° of the vertical"), *Ackworth*, and *York* enable us to determine the direction and position of the central part of the lower edge of the cloud as seen from the north and east. They give a point just above Mirfield Junction, 9 miles S.S.W. from Leeds, 32 miles S.W. from York and 13½ miles W. of Ackworth. The Driffield direction passes the same spot. The only other record, Market Rasen, is very divergent, the observer there putting the centre point south of west, whereas Mirfield is north of west.

The altitude of this point was capable of closer determination, thanks to references to Venus and Jupiter. The results of careful reductions are given in degrees in the following table, accompanied by the corresponding heights in miles, and distances and directions from Mirfield.

Place.	Miles from Mirfield.	Direction from Mirfield.	Altitude in degrees.	Resulting height above Mirfield.	Observer.
[1]Ackworth ...	13½	E.	40° (?45°)	11 (?13½)	C. J. Evans, &c.
Tadcaster ...	22	N.E.	35°–40°	15	C. Rawson.
[1]York	32	N.E.	22½°	13½	J. E. Clark.
Wetwang ...	50	E.N.E.	16½°	15½	E. M. Cole.
Driffield ...	56	E.N.E.	10°–15°	16	J. Lovell.
Hull	54½	E. by N.	12°	13	S. Bowen.
[1]Market Rasen	58	E.S.E.	16°	15	W. Whiteman.
[1]Sunderland ...	88	N. by E.	7½°	14	T.W. Backhouse.

The adopted height from the above eight records is 14 miles, or 75,000 feet.

The Leeds record gives 25 miles, but Prof. Lupton wrote only from memory, in response to inquiry after some interval. It may, however, indicate that the south-west edge of the cloud was more nearly above Leeds. By shifting it 4 miles in that direction the Leeds height becomes 16 miles, and that for Ackworth 11½ miles, Tadcaster 12½, York 12, and the rest, except Market Rasen (unchanged), become half a mile less. The mean result, taken as before, but now including Leeds, is 13·6 miles, or substantially the same.

[1] As the records at these stations appeared to be much the more trustworthy, *double weight* is given them in the reduced value. In the Ackworth value, four times the weight is assigned to the 40° as to the 45°, the latter, on inquiry, being stated to be less probable.

The more distant localities did not, of course, view the same *edge* as those nearer, but one which must have been rather nearer them and lower down. Thus they are subject to a positive and a negative source of error, which cannot be well estimated, but which fortunately tend to neutralize each other.

The resulting height is unexpected, but the records agree so nearly as to leave little doubt of its substantial accuracy. Mr. Backhouse's measurements were made merely for altitude and an hour later, but the cloud-shift was so slight that it has been included. J. EDMUND CLARK.

A Dust Storm at Sea.

A FEW days ago, while returning to Tokio from the southern part of Japan, I joined the s.s. *Yokohama Maru*, which, whilst crossing from Shanghai to Nagasaki had passed through a curious dust storm. Small quantities of the dust were yet to be seen in sheltered corners of the vessel. The commander, Captain R. Swain, who gave me a specimen of the material, told me that on April 2, when about 95 miles west by south of Nagasaki (long. 128° E., lat. 32° 20′ N.), at about 6 p.m. the sun appeared quite yellow. The atmosphere was moist, and rendered everything upon the deck of the ship quite damp. The precipitated moisture was yellowish, and as it dried it left an extremely fine powder. For two days previously the wind had been blowing west-south-west, or from China. Nothing was felt in the eyes, and if the ship had not been covered with yellow powder, the phenomenon would have been regarded as an ordinary but peculiarly coloured fog.

The yellow atmosphere was noticed during the afternoon of the 2nd. At midnight the wind changed to north-west—that is, from Corea. The probability, however, is that the material came from the loess plains of China. In Nagasaki, which is 390 miles from the coast of China, a yellow sun was noticed on the morning of the 2nd; and during the day, whilst dust was being precipitated, the appearance of the atmosphere was compared to that of a London fog.

On April 1 there was a fall of dust in the neighbourhood of Nawa in Okinawa-ken, and on the 2nd dust fell in Gifu—the district where the recent great earthquake took place. The P. and O. s.s. *Verona*, which left Hong Kong on April 1, experienced the same phenomenon as the *Yokohama Maru*, the vessel being covered with a fine dust, which, when suspended in the atmosphere, gave rise to so much haze that land was not seen until reaching Nagasaki. On April 3 a yellow sun was seen in Yokohama, but I am not aware that any dust was observed. Roughly speaking, it therefore seems that on April 2, at a distance of from 200 to 400 miles from the coast of China, there was a cloud of dust which may have been over 1000 miles and possibly 2000 miles in length. Dr. B. Koto, who examined a specimen, tells me that the particles are chiefly felspar, but there is a little quartz and shreds of plants. JOHN MILNE.

Tokio, April 23.

Submerged Forest.

DURING a recent visit to an East Lincolnshire seaside place, Mabelthorpe, the remains of a submerged forest were pointed out to me plainly visible at low water. On closer inspection, the stumps of fallen trees, firmly embedded in the clay from one to twenty inches above the surface could be traced along the low-water level. I should be much obliged if any reader could fix a date at which the forest was growing. Does it not prove a subsidence of land in the neighbourhood? M. H. M.

Carnivorous Caterpillars.

I SHOULD like to know if it is a known fact that some caterpillars are carnivorous, eating their own kind, and small ones of another kind? I have found on a lime-tree on our lawn, six caterpillars, two of which have done so.

One of them has (though there was plenty of food, as I had only taken it from the tree a few minutes) eaten one of its own kind about three-quarters its own size; and later on in the day a small green looper (off the lime-tree), which was in the same box. A second has eaten two small loopers. The other three I only found to-day, and they are not as large as those which had eaten their fellows.

I cannot find a description of this caterpillar in "Das Buch der Schmetterlinge" (Lutz), which I use.

They are of a bright green, the colour of the young lime leaves, with a narrow white line down the back and along each side half-way down, and a broader one lower down. Between this and the narrow side-stripe are three very small black spots; between the back line and the narrow side-line, are two black spots, to each segment. Each spot has a white edge. On the first two segments the upper two spots are one under the other; but on the rest are side by side. The three spots form an L, with the two lower ones very near, or on the broad side-line.

They have eight prolegs, as well as the two suckers at the back. They appear very irritable, and swing their heads from side to side when touched, and apparently nip other caterpillars which dare to touch them in any way.

I may also mention that there are three very fine specimens of the Red Admiral (*Vanessa Atalanta*) in our garden to-day and yesterday. JULIET N. WILLIAMS.

Blackbrook, Bickley, Kent, May 29.

THE HURRICANE IN MAURITIUS.

THE devastation caused by the hurricane in Mauritius was so terrible that it was hardly to be expected the Observatory would be spared. We are glad to say, however, that it suffered no damage; and all meteorologists will congratulate themselves that the well-known Director, Mr. Meldrum, was able without delay to prepare an account of the storm. The account is printed in the special overland edition of *The Merchants and Planters Gazette*, May 11. We here reproduce it:—

"*Saturday, April* 30.

"The hurricane which raged for a few hours yesterday, April 29, has in many respects been unprecedented in Mauritius.

"Never till now has the island been visited by a hurricane at any time between April 12 and December 1. Hitherto the hurricane season of Mauritius has been supposed to begin on the latter and to end on the former day, and till yesterday there has been no exception to the rule.

"Nor was there any sign of danger till yesterday, when the barometer began to fall rapidly and the wind to increase to a heavy gale. The suddenness, rapidity, and extent of the changes which took place in a few hours are unparalleled in the annals of the colony.

"The following table will for the present suffice to convey some idea of the changes which took place in the barometric pressure and the direction and velocity of the wind from 9 a.m. on the 24th to 9 p.m. on the 29th:—

Day and Hour.	Barometer.		Wind.	
	Cor. and reduced to sea-level.	Fall or Rise per hour cor. for var.	Mean Direction.	Velocity in miles per hour.
	Inches.			
April 24				
9 a.m.	30·059	—	E.S.E. ½ S.	3
April 27				
9 a.m.	29·903	—	E. by S.	15
April 28				
9 a.m.	·905	—	N.E. by E.	12
4 p.m.	·816	−0·003	N.E. by E.	14
9 p.m.	·850	−0·006	N.E.	12
April 29				
6 a.m.	·660	−0·018	N.E. by E.	22·4
8 ,,	·630	−0·029	N.E. ½ E.	34·7
9 ,,	·576	−0·063	N.E. by E.	35·0
10 ,,	·480	−0·094	E.N.E. ½ N.	40·0
11 ,,	·338	−0·131	N.E. by E.	52·0
Noon	·066	−0·251	N.E. ½ E.	68·0
1 p.m.	28·517	−0·532	N.E. ½ E.	96·5
2 ,,	27·990	−0·513	N.	56·0
3 ,,	28·034	+0·048	W.N.W.	68·0
4 ,,	·520	+0·483	W.S.W.	112·0
5 ,,	29·059	+0·529	S.W.	82·0
9 ,,	·719	+0·151	S. Wrd.	26·0

"In the above table the fall or rise in the barometric pressure is corrected for the daily variation, and from 9 a.m. on the 24th to 9 a.m. on the 29th the mean hourly velocities of the wind are given, whereas from 10 a.m. to 5 p.m. on the 29th the rates of the velocity per hour are given as obtained from observations taken during intervals of two to five minutes.

"It will be seen that at 2 p.m. on the 29th the barometer was at 27·990 inches; that from noon to 2 p.m. it fell 1·045 inch; that from 3 to 5 p.m. it rose 1·012 inch; and that from 5 to 9 p.m. it rose ·660 inch. The absolutely lowest pressure was 27·961 inches at 2.30 p.m., which is the lowest on record in Mauritus.

"From 9 a.m. on the 28th to 1 p.m. on the 29th the mean direction of the wind did not vary much, but it occasionally showed a tendency to veer towards north, being at times from north-east by north to north-north-east. Between 1 and 2 p.m. it on the whole veered to north, and between 2 and 3 p.m. to west-north-west, oscillating considerably, and soon after settling down at west-south-west.

"After 11 a.m. the velocity of the wind increased much, being at 1 p.m. at the rate of 96·5 miles an hour, and at 1.20 at the rate of 104 miles. But from 1.25 to 2.30 p.m. there was a lull, the velocity decreasing to the rate of 43 miles an hour at 2.33 p.m. It then began to increase again, and at 3.47 p.m. was at the rate of 121·2 miles per hour, but it soon began to abate, being at the rate of 72 miles at 5·20 p.m., 60 miles at 6 p.m., 47 miles at 7 p.m. and 26 miles at 9 p.m. By this time the weather was fine, the sky partially clear, and here and there stars shining brightly.

"Seeing that from 9 a.m. on the 24th to 9 a.m. on the 27th the barometer had fallen from 30·059 to 29·903 inches, and that the wind, though light, had veered from east-south-east half south to east by south, a note was sent to the newspapers on the latter day, stating that there was heavy weather to the northward, and that it had existed since the 24th; which, as usual in such circumstances, meant that there were indications of a cyclone away to the northward and that it was travelling from north-eastward to south-westward.

"But the wind having by 9 a.m. on the 28th reached north-east by east, and the barometer being higher on the 27th at the same hour, there was no apprehension; and in the afternoon of the 28th, the wind being still moderate from north-eastward, and the barometer falling at the rate of only 0·003 inch per hour, it was announced that there was no fear.

"As already stated, it was only on the 29th that the conditions became unfavourable, and at 9.40 a.m. a telegram was despatched announcing that the barometer was falling at an accelerating rate.

"Other telegrams, despatched at 11 a.m., announced that the velocity of the wind was at the rate of 52 miles an hour in the squalls, and that probably it would not exceed 56 miles an hour. Soon afterwards the telegraph wires were broken, and all communication ceased.

"The barometer continuing to fall at an accelerating rate, and the mean direction of the wind being nearly constant, it was inferred that the centre of the depression would, contrary to long experience (the wind being from north-east) pass over the island, and that the wind would then come from nearly the opposite direction.

"The centre, however did not pass over the Observatory, but over a point about six miles to the westward of it, and apparently from that point it travelled across the island on an east-south-easterly course.

"As a rule, when the wind is from north-eastward, there is scarcely any danger of a hurricane in Mauritius. All our great hurricanes have commenced, not with a north-easterly, but with a south-easterly wind; and this is why, when the wind was from north-east by east at 11 a.m. yesterday, and the barometer at 29·338, it was considered probable that the velocity of the wind would not exceed 56 miles an hour. On February 12 last, the barometer fell to 29·325, and the greatest velocity of the wind was 47·5 miles per hour from north-east, the barometer soon afterwards rising and the wind decreasing.

"There are, apparently, only two ways of, in a measure, accounting for the passage of the centre of a hurricane over the island yesterday from west-north-westward to east south-eastward. Firstly, the cyclone which had been travelling to the northward and north-westward of the island on a south-westerly course, from the 24th to the 27th, recurved to the southward and south-eastward; or secondly, a small secondary cyclone, which was generated in the south-east quadrant of the larger cyclone, travelled to the east-south-eastward, and bore down on Mauritius. The latter is perhaps the more probable hypothesis; for the small but violent hurricane of yesterday, with respect to its extent, duration, &c., exhibited the characteristics of a local atmospheric disturbance.

"On the night of the 27th and morning of the 28th there was a great deal of thunder and lightning, and also frequent lightning during the night of the 28th. But the hurricanes of Mauritius are seldom, if ever, immediately preceded by thunder and lightning.

"It may be stated, also, that from the 25th to the 29th there were from five to six groups of sun-spots, indicating a considerable increase of solar activity; and that from the 25th to the 28th there were large magnetic disturbances, the portion of the sun's disk on which there was a very large group of spots on February 12 being again on or near the sun's central meridian.

"C. MELDRUM."

PROFESSOR JAMES THOMSON.

PROF. JAMES THOMSON, who died on May 8, after a few days' illness, the result of a chill, was born in Belfast in 1822. He was the son of James Thomson, who was then Lecturer on, and afterwards Professor of, Mathematics in Belfast, and subsequently became Professor of Mathematics in Glasgow University. The father was a highly successful teacher and original investigator in mathematics, and was the author of many important school books. One of these books was, thirty years ago, still the recognized text-book on arithmetic in Ireland, and in all probability still retains its position. It was referred to by its very well-known title the "Thomson," by Prof. Tyndall in his British Association Address in 1874. We do not need the assurances of contemporaries, which are plentiful, that the two boys, James and William Thomson (now Lord Kelvin), made brilliant progress in their father's subject, and exhibited, even in early days, that combination of inventive genius and painstaking effort for accuracy, which have been their great characteristics since. James took his M.A. degree at Glasgow, served an apprenticeship under Sir William Fairbairn, and practised in Belfast as an engineer. He held the appointments of engineer to the Belfast Water Commissioners and to the Lagan Canal Navigation Works. In 1857 he became Professor of Civil Engineering in Queen's College, Belfast, and his Belfast pupils are to be found occupying high positions in every part of the world. He succeeded Rankine in Glasgow in 1872, and resigned the Professorship at Glasgow in 1889 because his eyesight was failing. He became a Fellow of the Royal Society in 1877. He received the honorary degrees of D.Sc. from the Queen's University of Ireland, and of LL.D. from Glasgow and from Dublin. In 1853 he married the only daughter of the late Mr. William John Hancock, J.P., of Lurgan, Co. Armagh, and it is a pathetic circumstance connected with his death, that she and one of his daughters survived him only a few days. He leaves a son and another daughter.

In his private engineering practice at Belfast, he carried out important work in hydraulic machinery for use at home and in foreign countries. He invented the inward flow vortex turbine, and even now there are men in Ulster who are willing to talk at great length about his troubles and successes with this turbine. There was no practical man, however clever, who did not at first ridicule the scientific young gentleman who proposed to replace an eighty foot wheel by a tiny turbine, whose wheel was less than a foot in diameter. He never in his life could have had a happier moment than that in which, surrounded by crowds of astonished rustics and practical engineers, he saw this tiny wheel in its very first trial, driving the machinery of a large mill. And now, wherever turbines are to be found all over the world, they are mostly "Thomson" turbines, made on the principles so clearly thought out and described by him, albeit they are known under many very different names. His notions on such subjects as strength of materials and the effect of initial strains in materials, although published forty-four years ago, have only lately become the notions of practical engineers. At that early date, his ideas on many of the applications of science in engineering were very clear and correct, and far in advance of his contemporaries. He is especially to be recognized for his services in practical hydrodynamics, a subject in which there has been a more misleading appearance of mathematical theory than in any other branch of engineering. To one of Thomson's pupils it is positively painful to take up any authoritative treatise on hydraulic machinery, for he knows that nearly every page of troublesome mathematical reasoning is based on some absurd assumption, and that James Thomson's few propositions are almost the only ones on which the engineer can rely. James Thomson seemed to fear the misuse by young engineers of the recognized mathematical methods of attacking physical problems. He, himself, when he used mathematical expressions, used them merely to put before others the results of his own method of reasoning. It expresses only a part of the truth to say that he thought about things geometrically rather than algebraically. He refrained from publication until his proof was perfect, and some of his pupils may feel sorry that they have not more faithfully followed their master's example. A study of his successive manuscript proofs of his law of flow of fluids from similar orifices would probably enable us to conceive of the habits of thought of the Greek geometers: every word and phrase is carefully selected, and considered time after time with a view to perfect accuracy. Such invention and such regard for perfection of detail were surely never combined before.

When any of his speculations has been once published in an authoritative text-book, it will be noticed that it appears in all text-books published subsequently; the melting point of ice, the triple point in water-stuff, the continuity in the steam water isothermal, the tears of strong wine, are a few examples. No doubt, as time goes on, text-book writers will find that he discovered other important things. He was such a very observant man that he often put forward his most important propositions when explaining phenomena that seemed utterly insignificant. Let the reader only think that what occurs in a wash-basin, or in a little rivulet near the sea, may be of great importance scientifically, and let him read again some of Thomson's insignificant-looking scattered papers, and he will find important propositions published which will not, perhaps, for some years yet, find their proper positions in the text-books.

Of the history of thermodynamics during the eventful years 1849-50, who dares now to say anything? Nor can anyone now say anything about the great glacier dispute. One thing is certain, however, that James Thomson's discovery of the necessary lowering of the melting-point of ice with pressure, published on January 2, 1849, settled for ever the theory of the flow of glaciers. Joule's work was beginning to be known, but Thomson, in his proof, like Lord Kelvin in the well-known paper published on the same day, adopts Carnot's idea of the conservation of heat. A change in one expression, not essential to the proof itself, was all that was needed after the first and second laws of thermodynamics had been recognized. Of his various papers on hydrodynamics, capillarity, heat, light, and the states of matter, published since that time, we have not space to say more than that each of them made a substantial addition to our knowledge. His latest work, the Bakerian Lecture this year of the Royal Society, on "The Grand Currents of Atmospheric Circulation," is such a paper as we might expect from a man who had given more than thirty-five years of study to the subject, that subject being one which was peculiarly his own. It is possible that the practical engineer, judging from the title merely, may neglect to read a paper which is one of phenomenal importance to the engineer as well as to the physiographer.

He was a man of singular purity of mind and simplicity of character, very clear-sighted in all that pertained to moral right and wrong, and conscientious to a degree. In his presence one felt in a purer atmosphere, where mean things seemed impossible. No Professor was ever so willing to take trouble (not mere momentary trouble, but trouble of days and nights) in the interests of a student, but no Professor was ever so rigidly exact in giving certificates and testimonials. The present writer has talked often with his old pupils about him, but never met one of them, who, besides a great respect, had not also a genuine and kindly and pleasurable love for his old Professor, whose kindness and patience had been unfailing, and whose sympathy had many a time been extended to him. How useless it is to speak of the good done to the world by a man of his character. Every one of his pupils, in however small or great a degree, is extending the range of his influence.

JEAN SERVAIS STAS.

The regret expressed in the obituary notice of Jean Servais Stas, that we had not the exact words of his famous discourse delivered before the King of the Belgians, has attracted the attention of a correspondent, who has very courteously sent us the text of the speech.

It was delivered by J. S. Stas in his capacity of President of the Royal Academy of Sciences, and was addressed to the King at the New Year's reception, January 1, 1891. We have much pleasure in laying a translation of it before our readers:—

"Sire,

"The Royal Academy of Science, Literature, and the Fine Arts expresses its sincere wishes for the happiness of your Majesty, and the prosperity of your reign.

"As the central organ of the intellectual movement of the country, the Academy seeks to comprise within its arms the most varied talents, and to remain always an adequate and living expression of the entire activity of the human mind.

"This is both its duty and the reason for its existence.

"In the sphere of Literature and Art its voice is almost always safely guided by public opinion—a competent judge of works accessible to all.

"It is otherwise in the sphere of Science.

"The physical, mathematical, and natural sciences, and even the moral and political sciences, do not appeal in the same degree to public opinion. If their conquests radiate afar, if they incessantly modify the conditions of social existence, they themselves develop in restricted circles, and work out of sight and of knowledge of the multitude.

"The Universities, Sire, in our country especially, are the principal foci of scientific life. There not only the men of science of the future are trained, but the present representatives of higher research work, create, and distinguish themselves. There also the Royal Academy by preference seeks its fellows to associate them in its task and to render it fruitful.

"Its mission cannot be divorced from that of the institutions for higher education, and their lustre and their decline are simultaneous.

"In the name of this great and twofold interest the President of the Royal Academy feels bound to call the attention of your Majesty to the mode of appointment to the professorial chairs in the State Universities.

"The method adopted is absolutely faulty, and it affords to Science none of those guarantees which she has a right to demand.

"The intensity of party strife has the effect of absorbing into its vortex even those acts of the public authorities which ought to be least open to its influence. In place of conferring the University chairs upon the most capable men as their rightful prerogative, with the sole thought of raising the level of studies and of enlarging the intellectual patrimony of mankind, we too often see the spirit of faction disposing of such positions arbitrarily, to the injury of the scientific spirit.

"An incompetent professor paralyzes for a quarter of a century, even if he does not kill, instruction in the department committed to him. An improper nominee is a denial of justice.

"The courts of law have been invested with the right of presentation to vacant judgeships; an analogous prerogative ought to be conferred on the faculties of the Universities. Their choice would then be dictated by considerations essentially scientific, and to this end the Royal Academy relies on the great influence of the King."

"The King," adds the *Indépendance Belge*, "did not accept this appeal to his influence, and the Ministers present bestowed black looks upon the President of the Academy."

This impressive discourse has its lessons for us also, as it emphasizes the necessity of conferring scientific appointments purely in accordance *rebus gestis*, and in consideration of the actual work done by the candidate.

W. C.

NOTES.

THE annual *conversazione* of the Royal Society will be held on Wednesday, June 15.

AT the annual meeting for the election of Fellows, held on Thursday last, the Royal Society elected the fifteen candidates whose names, with the statement of their qualifications, we have already printed.

THE British Medical Association will hold its sixtieth annual meeting at Nottingham on July 26, and the three following days. Mr. Joseph White, consulting surgeon of the Nottingham General Hospital, will preside. Addresses will be given, in medicine, by Prof. James Cumming, of Queen's College, Belfast; in surgery, by Prof. W. H. Hingston, of Montreal; and in bacteriology, by Dr. G. Sims Woodhead, of the Research Laboratory of the Colleges of Physicians and Surgeons, England. The scientific work of the meeting will be done in ten sections.

AT a meeting of the American Philosophical Society, Philadelphia, on May 20, it was decided that the one hundred and fiftieth anniversary of the foundation of the Society should be worthily celebrated in 1893, and a committee was appointed to make the necessary arrangements.

THE Federated Institution of Mining Engineers held their general meeting in London on Thursday and Friday last. At the meeting on Thursday papers were read on "Gold Mining in New Zealand," by G. J. Binns, and on "Petroleum in Eastern Europe and the Method of Drilling for it," by A. W. Eastlake. Prof. T. E. Thorpe gave some practical demonstrations of the action of coal-dust when exploded with gas. The members visited the Electrical Exhibition at the Crystal Palace in the afternoon, and dined together at the Garden Hall in the evening. Among the papers read at the meeting on Friday were papers on "The Causes of Spontaneous Combustion of Coal and Prevention of Explosion on Ships," by M. V. Jones; "A Safety-cage for Mines and Hoists," by J. Whitelaw; "Winding by Water-balance at Ynis Merthyr Colliery," by M. W. Davies; and "Gold Milling," by W. F. Wilkinson.

THE Aldini Medal for Animal Electricity has been awarded to Dr. A. Waller, Lecturer on Physiology, St. Mary's Hospital Medical School, by the Bologna Academy of Sciences.

THE Council of the Institution of Electrical Engineers decided that the Salomons Scholarship of £35 should be given to a second year's student training to become an electrical engineer at either King's College, University College, the City and Guilds Central Institution, or the Finsbury Technical College. The first award has just been made to C. H. C. Woodhouse, Matriculated Student of the Central Institution, Associate of the Royal College of Science, and B.Sc. of the London University.

AT the annual meeting of the Institution of Civil Engineers Mr. Harrison Hayter was elected to act as President for the ensuing year. The Vice-Presidents are Alfred Giles, Sir Robert Rawlinson, Sir Benjamin Baker, F.R.S., and Sir Jas. N. Douglass, F.R.S. The following are the other members of Council:—W. Anderson, F.R.S., J. Wolfe Barry, Alex. R. Binnie, E. A. Cowper, Sir Douglas Fox, J. C. Hawkshaw, Charles Hawksley, Sir Bradford Leslie, George Fosbery Lyster, James Mansergh, Sir Guildford L. Molesworth, W. H. Preece, F.R.S., Sir Edward J. Reed, F.R.S., William Shelford, and Francis W. Webb.

IN the official abstract of the report of the Council of the Institution of Civil Engineers for the session 1891–92, it is stated that 59 associate members had been transferred to the class of member, and that there had been elected 3 honorary members, 28 members, 324 associate members, and 7 associates, while 4 associate members had been restored to the register. These additions together amounted to 366. After deducting 145 names from deaths, resignations, and erasures, there was an increase of 221, bringing up the total number on the register to 5371, as against 5150 at the corresponding date last year. This enumeration was irrespective of the students, of whom 200 had been admitted during the year, as against 166 for the previous twelve months; but during this period, 106 students had become associate members, and 140 had disappeared from the list, so that the number now on the books was only 868, whereas last year the number was 914. Thus, including students, the total number on the books was now 6239, as against 6064 twelve months ago. The following awards have been made to the authors of papers which have been discussed:—A George Stephenson Medal and a Telford Premium to Mr. Alex. R. Binnie; Telford Medals and Telford Premiums to Mr. A. P. Trotter and Mr. W. T. Douglass; and Telford Premiums to Messrs. H. Alfred Roechling, A. H. Curtis, W. Airy, H. Gill, and Prof. W. C. Roberts-Austen. In respect of communications which have been deemed suitable for printing without being discussed, Telford Medals and Telford Premiums had been adjudged to

Messrs. F. Fox and Alfred W. Szlumper; and Telford Premiums to Messrs. Sheibner, T. H. Beare, W. C. Unwin, E. Penny, A. D. Stewart, R. H. B. Downes, and W. Mathews. The Howard Quinquennial Prize had been awarded to Sir Isaac Lowthian Bell, Bart., F.R.S., for his treatise on "The Principles involved in the Manufacture of Iron and Steel." The papers read at supplemental meetings of students had shown in nearly every case evidence of having been prepared with care. Three, at least, were of high merit, and, with four others above the average, had been deemed worthy of publication, either in whole or in part, in the Minutes of Proceedings. For these seven papers the Council have awarded the Miller Scholarship to Mr. H. B. Ransom for his paper on "Fly-Wheels and Governors," and Miller Prizes to Messrs. C. H. Wordingham, E. L. Hill, D. Carnegie, G. H. Sheffield, J. B. Ball, and R. J. Durley.

AT the second annual dinner of the Institute of Marine Engineers, held last Thursday, Lord Kelvin, the President, said in the course of his inaugural address that the institution was one which he thought could not fail to be of the greatest service to the cause of marine engineering. He had only to go back to the days of his youth to recall the immense strides which had been made in this great industry. His father was an Irishman, as he himself was, and he used to cross the Channel from his home in county Down as best he could to land at some point on the coast of Scotland and find his way to the University of Glasgow, there to pursue his studies. He used to make the passage in whatever sailing vessel he could find taking the cattle across, and the time of the passage was not part of the bargain. On one occasion he sailed from Belfast to Greenock in twelve hours; on another he was four days on the passage, and sailed three times round Ailsa Craig. It was only necessary to state such facts to show how vast had been the progress since those days. No branch of engineering, no branch of science which aimed at supplying the wants of mankind, had made greater progress in the last sixty years than that. He was not forgetting railways or telegraphs; but he said advisedly that no branch of engineering had made greater or more splendid strides than marine engineering.

MISS DOBERCK, who has been appointed assistant meteorologist in Hong Kong, is the sister, not the daughter, of the present Director of the Hong Kong Meteorological Observatory.

ACCORDING to a telegram from Naples, dated June 7, the eruption of Mount Vesuvius, which had been noticeable for some little time, had considerably increased in volume, and large masses of lava were flowing into the Atrio di Cavallo ravine.

ON June 7, at 12.30 a.m., an earthquake shock was felt at San Severo, in the province of Foggia, and an adjoining hamlet. The oscillations, which were of an undulatory character, created a temporary panic.

THE weather during the first part of the past week has been fine over the eastern and southern portions of England, but unsettled in Ireland and Scotland, with a considerable amount of rainfall, while the temperature was much lower, generally, than in the previous week, the daily maxima not exceeding 70°. On the morning of the 4th a disturbance appeared off the Irish coast and crossed our islands on Sunday, causing heavy rain in places, and thunderstorms in the eastern parts of England. The *Weekly Weather Report* for the week ending the 4th instant shows that during that period the rainfall exceeded the mean in all districts, excepting the east of England, where bright sunshine was very prevalent. Over Ireland and in the north of Scotland the excess above the normal rainfall was large, being 1·2 inch and 0·8 inch respectively, yet, reckoning from the beginning of the year, there was still a deficiency in all districts. On Monday, the 6th, a great increase of temperature occurred in most parts of this country, and the weather became much more settled, under the influence of an anticyclone which approached our islands from the southward, while the shade temperature in London reached 73° and 74° at Loughborough. During the early part of this week, the anticyclone became well established, and had caused the temperature to rise considerably in Scotland and Ireland, with prospects of settled, fine weather, generally.

MR. R. H. SCOTT has contributed an article, entitled "Notes on the Climate of the British Isles," to *Longman's Magazine*. The author gives some amusing instances of the distortion of facts at seaside stations, where the observers are anxious to prove the advantages of their own towns over those of their rivals. Taking the whole year round, the warmest spot is the Scilly Isles, which are a degree warmer than either the west of Cornwall or the Channel Islands; while the coldest region on the coast is the extreme north-east of Aberdeenshire. In winter very little difference of temperature is met with all along the east coast; but the coldest part of England lies round the Wash. With regard to the variability of temperature, or the difference of the mean temperature of an entire day, the equability of the temperature of these islands is very great. The only locality for which a more uniform temperature has yet been published is Georgetown (Demerara); the figure for this place is 1°·1, while for London it is 2°·7. All the great changes of temperature occur in winter, and accompany sudden thaws. As regards bright sunshine, the Channel Islands are by far the most favoured. On the mean of the whole year, Jersey secures 39 per cent.; but from the Bristol Channel to the coast of Norfolk there is but little difference in the amounts recorded. In cities like London the deficiency is due to smoke. The statistics relating to fog are not yet completely discussed, but so far as they go they show that in winter the foggiest district is the east coast of England. Next come London and Oxford, which are about equal. With regard to rainfall the east coast stations receive on an average of the whole year about half as much as those on the west coast, the amount being about 25 inches on the east coast, 30 to 40 inches between Sussex and Devonshire, and 50 inches to the south of Cornwall. In the west of Ireland the amount rises to 70 or 80 inches, owing to high land near the coast. The driest hour almost everywhere is noon.

MR. C. MICHIE SMITH has edited a work embodying "Results of the Meteorological Observations made at the Government Observatory, Madras, during the years 1861–90, under the direction of the late Mr. Norman Robert Pogson." The volume is published by order of the Government of Madras. It was Mr. Pogson's intention to issue the work as soon as he could after the completion of thirty years of observation, and at the time of his death a considerable part of the manuscript was nearly ready for press. In editing the work, Mr. Smith, so far as possible, has retained the original plan. He expresses much admiration for the skill and thoroughness with which the observations were organized and carried out.

THE Essex Field Club will probably hold its first dredging meeting of the season at Brightlingsea on Friday and Saturday, June 24 and 25. Other field meetings in course of arrangement are: Visit to Dagenham district (June or July); the Writtle Woods (July 30); Rochford and Rayleigh (August); on the Stour from Bures to Manningtree; visit to the Deneholes, &c.

THE Clarendon Press will publish immediately a second volume of Prof. Weismann's work on "Heredity and Kindred Biological Problems." It contains four essays, of which only the shortest has previously appeared in an English form (in the columns of NATURE). The first essay deals with degeneration, and clearly shows, by abundant illustrations, that it has resulted from *panmixia*, or the cessation of natural selection. The second is an attempt to explain the development of the art of music, and to show that the hereditary transmission of the results of practice is quite unnecessary in order to account for its rise. The third contains a reply to certain objections urged by Prof. Vines. It will be useful in giving clearer expression to the ideas on the death of multicellular beings and the immortality of the unicellular. The fourth and last essay is by far the longest and most important. It deals with the essential significance of sexual reproduction and conjugation, &c., as inferred from the results of the most recent researches. Prof. Weismann's older views on these subjects (especially concerning the polar bodies) have been modified and in part abandoned. The immortality of unicellular beings and the question of the transmission of acquired characters by them are also discussed in detail with reference to recent observations.

WE have received the first volume of the *Jahrbuch der Chemie*, a new periodical issued by the Frankfort publisher H. Bechhold. The editor is Prof. Richard Meyer, of Brunswick. Chemistry is now divided into so many departments that it is difficult for specialists to obtain an accurate idea of the recent progress of the science as a whole. The object of the *Jahrbuch* is to supply this need, and, if we may judge from the first issue, the work is likely to fulfil its purpose admirably. The editor has secured the co-operation of many well-known chemists, each of whom presents a general view of what was done last year in the department of research to which he himself is more particularly devoted. Thus there are, among other papers, reports on physical chemistry, by W. Nernst; on inorganic chemistry, by G. Krüss; on organic chemistry, by C. A. Bischoff; on physiological chemistry, by F. Röhmann; on pharmaceutical chemistry, by H. Beckurts; on agricultural chemistry, by E. F. Dürre; on explosives, by C. Häussermann; and on photography, by J. M. Eder and E. Valenta. In future issues the editor hopes to include the bibliography of each branch of the subject.

THE new number of Wundt's *Philosophische Studien* opens with a comprehensive paper by the editor on "Hypnotism and Suggestion." The subject is treated from the double standpoint of physiology and psychology; and the article should go far towards bringing about a saner tone of thought than that which is just now current, even in "educated circles." Mr. Titchener's chronometrical determinations reduce the recognition time of colours to 30, of letters and short words to 50 thousandths of a second. Dr. Merkel's article on the psychophysical error-methods is concluded; and Drs. Külpe and Kirschmann publish the results of a careful testing of the Hipp chronoscope (old pattern) by means of a new control-hammer.

ON Sunday last a terrible disaster overtook the petroleum district in Pennsylvania, especially the places called Oil City and Titusville. A thunderstorm, accompanied by torrents of rain, broke over the district, and the two cities were so quickly inundated by the swollen waters of Oil Creek that it was difficult for the inhabitants to escape to the hills, and many were drowned. Several refineries were struck by lightning, so that the unfortunate towns were devastated equally by fire and by water. It is supposed that about 200 persons lost their lives, while the destruction of property was enormous.

THE gallery in the South Kensington Museum assigned to the large collection of wrought iron work which has for some time been closed for rearrangement, was re-opened to the public on Whit Monday. The larger grilles and screens, including the gates from Hampton Court, are now placed in the arched spaces on either side, while the lanterns, cressets, signs, &c., are suspended along the gallery, smaller objects being shown in sloping glass cases. Among these last is a curious series of rush-candle holders, tobacco tongs, and other domestic implements used in England, chiefly in the eighteenth century, collected and lent by Lady Dorothy Nevill. Examples of the locksmith's art, English, French, and German, are numerous, including some chiselled steel locks and keys from old French buildings, but produced by "Johannes Wilkes de Birmingham" in the seventeenth century. Some of the more famous specimens of mediæval work in English cathedrals have been reproduced in facsimile. A hand-book on "Decorative Iron Work," prepared by Mr. Starkie Gardner, will shortly be published.

THE Board of Directors of the Zoological Society of Philadelphia have issued their twentieth report, and are able to give a good account of their work during the past year. Among the changes of the year was the establishment of "a cheap day," the price of admission on Saturdays and holidays (except the Fourth of July), having been fixed at ten cents for adults and five for children. The result has been satisfactory, the attendance having increased considerably, while there has been no material financial loss. Another fact noted in the report is that an offer of free admission to the Garden was made to the Board of Education for such classes of pupils of the public schools as seemed to the Board likely to profit by the privilege. Under the arrangement entered into, nearly ten thousand scholars of the public schools were admitted between September 23, when tickets were issued, and March 1, the end of the Society's fiscal year.

THE botanical section of the Imperial Museum of Natural History at Vienna is about to issue, under the name "Cryptogamæ, Exsiccatæ," a collection of named Cryptogams to its contributors, and in exchange for other similar collections.

THE Indian papers report that, under the auspices of the Government and Secretary of State for India, an important work, illustrative of the famous Ajanta Cave mural paintings, will be published shortly. The bulk of the work will consist of 173 imperial folio plates, mostly produced in chromo-collotype, by Mr. Griggs, of Peckham, the accompanying text being from the pen of Mr. John Griffiths and Dr. James Burgess, C.I.E.

FROM an official return just published it appears that during 1891 the total number of persons killed in the Punjab by wild beasts and snakes was 861, or one less than during the previous year. The great majority died of snake-bite, only 65 deaths being attributed to wild beasts. On the other hand, of the 966 cattle reported to have been destroyed, only 38 were killed by snakes.

MR. W. S. KEY calls attention, in the American journal *Electricity*, to the difficulty which manufacturers of electrical devices in the United States experience in obtaining iron adapted for electrical purposes. They complain of the inferior quality of the iron, the trouble in obtaining such brands as are in every way suitable, magnetically considered, for use in electrical devices such as dynamo and motor armatures, transformers, &c. They also complain of the irregular and unsatisfactory manner in which it is too generally annealed and finished by rolling, scaling, &c. Some of these manufacturers have for years used imported English, Welsh, and Swedish iron, which is necessarily of high price. They have also used Pennsylvania iron of high quality, but as yet have failed to discover just the quality they need. Mr. Key's experience in connection with a well-known firm in England has convinced him that iron such as is wanted in electrical manufactures might be produced if proper methods were adopted. "To secure such iron," he says, "of course a full and accurate knowledge of the qualities of the various brands of pig-iron now on the market would be a prime requisite; none the less would a correct knowledge of mixing be essential, while the rolling, scaling, and annealing would all have to be very carefully attended to if satisfactory results were to be attained."

AN important series of bibliographies relating to the more prominent groups of the languages of the North American Indians, by J. C. Pilling, is being issued by the Smithsonian Institution. The numbers concerning the Eskimauan, Siouan, Iroquoian, and Muskogean families are already known to students of these languages; and now a fifth number, giving the bibliography of the Algonquian languages, has been published. The sixth will include the languages belonging to the Athapascan stock. The volume on the Algonquian languages contains 2245 titular entries, of which 1926 relate to printed books and articles, and 319 to manuscripts. It consists of 614 closely-printed pages, and represents an amount of well-directed labour for which Mr. Pilling deserves the cordial recognition of all who will in any way profit by his researches.

THE atomic weight of copper has been redetermined by Dr. Richards, and an account of his work will be found in two papers contributed to the new *Zeitschrift für Anorganische Chemie* (pp. 150 and 187). From the results of experiments concerning the replacement of silver in silver nitrate by metallic copper, Dr. Richards was led to believe that the number usually accepted for copper, 63·3, was considerably too low. He has, therefore, thoroughly investigated the methods by which the old number was obtained, and made a new series of determinations, in which corrections have been applied for the errors due to the mode of analysis adopted. In the year 1874 Hampe made two series of determinations of the atomic weight of this element. One of these, in which the amount of metallic copper contained in copper oxide was estimated, gave the value 63·34; the second, which depended upon the copper content of anhydrous copper sulphate, yielded the number 63·32. The lower of these values has since been generally accepted as representing most probably the true atomic weight of copper, on account of the extreme manipulative care taken by Hampe, and the remarkable agreement of the individual experiments. Dr. Richards, however, has discovered a flaw in the method. Hampe dried his sulphate of copper at 250°; but Dr. Richards has experimentally proved that the so-called anhydrous sulphate obtained at this temperature loses about 0·17 per cent. of its weight when heated to the temperature of the vapour of boiling mercury. This loss, moreover, when taken into account in calculating the atomic weight, brings up the figure almost exactly to that indicated by the replacement of silver experiments. An exhaustive investigation has eventually shown that copper sulphate retains 0·12 per cent. of its water of crystallization, even after it has been subjected to a temperature of 400°. Indeed, this last trace of water is only eliminated at a temperature at which the sulphate itself commences to decompose. Dr. Richards has therefore made a series of redeterminations of the atomic weight by Hampe's method, drying the salt at 250°–270°. On calculating directly from the figures obtained, the experiments gave the mean value 63·35, a result almost identical with that of Hampe. But upon applying the correction for the slight amount of water still retained at this temperature the mean value is raised to 63·60.

IN the second communication Dr. Richards discusses the mode of determining the atomic weight by ascertaining the amount of copper contained in copper oxide. He shows that copper oxide which is prepared by the method employed by Hampe, ignition of the oxynitrate, contains four or five times its volume of occluded gases, and that even at a bright red heat only a portion of this occluded gas can be expelled. Dr. Richards has therefore made a series of redeterminations by this method, applying the necessary correction for occluded gas, the correction having been very accurately ascertained from a large number of observations. The final mean value of the atomic weight of copper afforded by the whole of Dr. Richards's experiments is 63·604 (oxygen = 16), the maximum and minimum values being 63·609 and 63·600 respectively. If the value of oxygen is taken as 15·96, that of copper becomes 63·44.

THE additions to the Zoological Society's Gardens during the past week include two Four-horned Antelopes (*Tetraceros quadricornis* ♂ ♀) from India, presented by Mr. H. M. Phipson, C.M.Z.S.; a Huanaco (*Lama huanacos* ♂) from Bolivia, presented by Mr. Frank Parish, F.Z.S.; a Black-necked Hare (*Lepus nigricollis*) from Ceylon, presented by Mr. T. C. Kellock; a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss Ruxton; a Masked Parrakeet (*Pyrrhulopsis personata*) from the Fiji Islands, presented by Mr. A. B. Holdsworth; a Booted Eagle (*Nisaëtus pennatus*), European, presented by Lieutenant J. E. Rhodes; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. Frank Allen; a European Pond Tortoise (*Emys europæa*), European, presented by Miss Lilian Powell; two Alligators (*Alligator mississippiensis*, jv.) from Florida, presented by Mr. R. White; a Moloch Lizard (*Moloch horridus*) from Australia, presented by Mr. John McLey; a Llama (*Lama peruana* ♂) from Peru, an Ostrich (*Struthio camelus* ♂) from Africa, a One-wattled Cassowary (*Casuarius uniappendiculatus*), a Common Crowned Pigeon (*Goura coronata* ♂) from New Guinea, two Victoria Crowned Pigeons (*Goura victoriæ* ♂ ♀), from the Island of Jobie, two Narrow-barred Pigeons (*Macropygia leptogrammica*) from Java, two Pale-headed Parrakeets (*Platycercus pallidiceps*) from North-East Australia, two Roseate Spoonbills (*Platalea ajaja*) from South America, two Vociferous Sea Eagles (*Haliaëtus vocifer*) from West Africa, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

LIGHT-VARIATIONS OF Y CYGNI.—The *British Astronomical Journal*, No. 266, contains two contributions from Mr. S. Yendell and Prof. Dunér, the former "On some observed minima of Y Cygni," and the latter "On the chief cause of the anomalies in the light-variations of Y Cygni." Mr. Yendell in his paper thoroughly agrees with the explanation put forward by Prof. Dunér to account for the anomalies in the light-variations, and says that, when the two series of observations are taken simultaneously, "the substantial correctness of his (Dunér's) fundamental assumption appears to me to be proved beyond the possibility of a cavil." It may be remembered that, in Prof. Dunér's former paper on this subject, he was struck with the discordance of some of Mr. Yendell's observations, which did not seem to harmonize with his own suggested explanation. These observations are now published in detail in this paper, and will be read with interest by those who are following up this curious variable.

Prof. Dunér, in a few words, discusses the results obtained when his own observations are compared with those of Mr. Yendell. The differences between the observed and calculated times of minima showed a decided rate of change, the mean rate being −0·023d., but lacked regularity. In one case the jump from one epoch to another amounted to a rate of − 0·056d., but he thinks that this may be accounted for by a variation in Mr. Yendell's method of observing, for other observations show altogether nearly constant deviations; indeed, "it will be more correct to attribute the discordance simply to errors of observation, than to anomalies in the light-variations of the star."

ACTIVE LUNAR VOLCANOES?—Prof. Pickering, in the *Observatory* for this month, raises the question of active lunar volcanoes, from some recent observations made with the 13-inch Clark, using powers varying from 800–1200. Examining first the Mare Serenitatis, of 67 craters 32 were found common to both charts, 24 on Neison's and not on Prof. Pickering's, while 11 were found on Prof. Pickering's and not recorded by Neison. With higher powers, all Neison's, except two, were discovered, and, in addition, several other small ones. Just about the region of Bessel a change seems to have taken place since Neison made his map, for there are one or two cases in which the crater-pits picked out by him for reference are now not the most conspicuous objects, there being several others far more prominent in the immediate vicinity. The floor of Plato also has been carefully scrutinized, and several of what were then more or less distinct luminous points are now either invisible or barely so, while one large crater was seen where previously none was recorded. Whether a real change has taken place in these parts of the moon's surface, or whether the antecedent observations were sufficiently accurate, is a matter of doubt, and it is for future observers to determine this. But now, as Prof. Pickering says, "that we are able to study the smaller lunar craters to advantage, and so many changes are noted, it does not seem as if the same cause (the mere action of sunlight) can have affected so many of them in the same way, nor does it seem as if all the changes noted can be due to erroneous delineation."

CATALOGUE OF NEBULÆ.—In *Astronomische Nachrichten*, No. 3094, the Catalogue No. 10 of nebulæ discovered at the Warner Observatory by Swift is inserted. The number included, which generally consists of one hundred, amounts here to sixty, the reason being that owing to the increasing number of electric street lights these faint objects are rendered invisible by the illumination of the atmosphere.

GEOGRAPHICAL NOTES.

DR. HENRY SCHLICHTER contributes a valuable epitome of our knowledge of the pygmies of Africa to the June number of the *Scottish Geographical Magazine*. He divides the dwarf tribes hitherto reported into four great groups, according to the regions they inhabit, recognizing, however, the probability of further exploration revealing connecting links between them. The first group, or dwarfs of West Africa, includes the Obongo, Akoa, and Babongo, which vary between 4 and 5 feet in height. The second, or Central African group, contains the Akka, Wambutti, and Batua, of even smaller stature, inhabiting the Congo Basin, scattered amongst Bantu tribes. The third group is that of the East African pygmies, whose existence east of the Nile and south of Kaffa was reported as early as 1826; but they are still little known. The fourth group, those dwelling south of the Congo basin, is relegated to another paper.

ORDNANCE MAPS of Great Britain are at last coming prominently before the public. Although not likely to gratify those engaged in producing the sheets, popular attention will doubtless result in direct and early benefit to cartography and even to geography at large. A Parliamentary Committee, on which scientific geographers are well represented, has the whole matter under investigation, and the energetic criticisms of Mr. Crook, which have so long passed unheeded, are now receiving further expression in a series of articles in the *Times*. The particular object of attack is the new quarter-inch outline map of England and Wales, a map put forward by the Survey with some natural diffidence, for it is founded on measurements the most recent of which were made twenty years ago, and the earliest at the very beginning of the century. The delineation of the country, in consequence of the want of subsequent revision, resembles a star-chart, in so far as it represents each point as it existed at some different time in the past. Unlike a star-chart, however, the quarter-inch map of England is of no scientific and little practical value. The more thoroughly this matter is investigated, and the more speedily it is rectified, the better will it be for the Survey officers, whose magnificent triangulations and unparalleled accuracy of observation have made the mapping of the British Islands a model for the world to admire. It is high time that steps be taken for regular periodical revision of all Ordnance maps, and for publication in a form comparable with that of the Staff maps of France and other Continental nations.

AN appreciative article on the late Prof. Freeman and his services to geography appears in the June number of the *Proceedings* of the Royal Geographical Society. Freeman's most important service was to demonstrate that the physical geography of a region largely determines the political geography of the countries upon it, and that a knowledge of past geographical conditions is essential in order to understand history.

THE report of an expedition to Argentine Tierra del Fuego by Señor Julio Popper has been recently published by the Argentine Geographical Society. The region in question is the eastern half of Tierra del Fuego, the geological structure of which is mainly Tertiary rocks much disintegrated; the coast line is little indented, with few harbours, the sea shallow and abounding in sand-banks, while the climate, dominated by the warm Brazil current, is equable and moist. The south coast bordering the Beagle Channel is rugged, rocky, and under the climatic influence of the cold Antarctic drift. The tribes inhabiting the island of Tierra del Fuego proper are the Ona (compare NATURE, xlv. 577), who are described as of fine physique, resembling the Indians of North America, and susceptible of civilization. Indeed, Señor Popper contrasts their magnanimous and forgiving character very favourably with the unreasoning cruelty of the white gold-seekers who have invaded their territory, yet the Onas are said to be inveterate thieves. The map accompanying this report is covered with new names for features already designated, and it can hardly be expected that these will be accepted by European geographers.

MRS. BISHOP (Miss Bird) read an interesting paper on her recent journey to Little Tibet, before the London branch of the Royal Scottish Geographical Society, on May 31, the Duke of Argyll presiding. Lady travellers are not encouraged to describe their expeditions to the Royal Geographical Society, and as the British Association, which receives communications from men and women on an equal footing, cannot meet in London, this opportunity for a metropolitan audience to hear at first hand the account of an adventurous journey, and the sympathetic estimate of the inhabitants of a little-known region, by a woman of Mrs. Bishop's tried courage and trained observing powers was naturally taken advantage of to the utmost.

MICRO-ORGANISMS IN THEIR RELATION TO CHEMICAL CHANGE.[1]

ALMOST exactly on this day twenty-two years ago the subject of micro-organisms was introduced to the audience of the Royal Institution in one of those charming discourses, which so many of us well know were always to be heard from Dr. Tyndall. The title of his discourse on that occasion was "Dust and Disease," and its contents should be studied by all interested in this departure of science, forming, as it does, a part of the classical literature of the subject in which it marks the commencement of a new epoch.

It has probably rarely, if ever, happened before, that in so short a period as twenty-two years any science has undergone such a marvellous advance, such a many-sided development, as that which has taken place in the case of bacteriology, the science which is devoted to the study of those low forms of life which we group together under the name of *micro organisms*. This advance has been made through the ungrudging expenditure of self-denying labour by a great body of earnest workers of nearly every nationality. The subject is, indeed, one calculated to draw forth interest and enthusiasm, for the problems involved are not only of high scientific importance, but are also of incalculable moment to mankind, and, indeed, to the entire living creation.

The great impetus which this new science received at its outset was imparted by Pasteur, who has not only laid the foundations, but has also added, and is still adding, so much to the superstructure of its many mansions.

The side of bacteriology with which the general public is most commonly brought in contact is that which relates to disease, but of this I propose saying absolutely nothing to-night. It has been dealt with by others in this place, and notably by my friend Dr. Klein.

There is a second side of bacteriology which has also a special interest for at least a portion of the public, in consequence of the invaluable assistance which it has afforded to some sections of the industrial world. Indeed, chronologically, this industrial department of bacteriology was the first which claimed attention, for the growers of wine, the brewers of beer, and the manufacturers of fermented liquors of all kinds from the highest antiquity have been practical bacteriologists, of the same spontaneous order, it is true, as M. Jourdain was an unconscious

[1] Friday Evening Discourse, delivered by Prof. Percy F. Frankland F.R.S., at the Royal Institution of Great Britain, on February 19, 1892.

author of prose. It was Pasteur also who first infused science into the operations of the wine-vat and the fermenting-tun, by his classical "Études sur la Bière et sur le Vin." It was he who first showed that the normal work of the brewery was accomplished by particular forms of micro-organisms, known as yeast, and that the frequent failures to produce beer or wine of the desired quality was occasioned by the presence of foreign forms of micro-organisms giving rise to acidity and other undesirable changes in these beverages.

In these researches of Pasteur's on beer and wine, we are almost for the first time brought face to face with the precise nature of some of the chemical changes which micro-organisms bring about. The time-honoured vinous fermentation of sugar, the products of which had been valued and indulged in by man even from the days of Noah, is for the first time so accurately studied as to be definable almost with the precision of a chemical equation.

Similar attention was also given by Pasteur to some of the other micro-organisms which deteriorate the quality of the beer—thus more especially to the bacterium which causes the *acetic* or vinegar fermentation, which is a process of *oxidation*, transforming alcohol into vinegar; to the bacillus inducing the *lactic* fermentation, which is a process of *decomposition*, in which sugar yields lactic acid; as well as to that which brings about the *butyric* fermentation, a process of *reduction*, in which butyric acid is formed.

These are the foundations and scaffolding on which subsequent investigators of the phenomena of fermentation have laboured. Thus, making use of more refined methods than those which were at the disposal of Pasteur, Christian Hansen, of Copenhagen, has enormously extended our knowledge of the alcohol-producing organisms or yeasts; he has shown that there are a number of distinct forms, differing indeed but little amongst themselves in shape, but possessing very distinct properties, more especially in respect of the nature of certain minute quantities of secondary products to which they give rise, and which are highly important as giving particular characters to the beers produced. Hansen has shown how these various kinds of yeast may be grown or cultivated in a state of purity even on the industrial scale, and has in this manner revolutionized the practice of brewing on the Continent. For during the past few years these pure yeasts, each endowed with particular qualities, have been grown with scrupulous care in laboratories equipped expressly for this purpose, and these pure growths are thence despatched to breweries in all parts of the world, particular yeasts being provided for the production of particular varieties of beer. In this manner scientific accuracy and the certainty of success are introduced into an industry in which before much was a matter of chance, and in which nearly everything was subordinated to tradition and blind empiricism.

The Bacteria connected with the Soil.

It is, however, with regard to the bacteria connected with other industries than those of alcoholic fermentation that our knowledge has particularly advanced during the last few years. Thus some of the most important phenomena in agriculture have recently received a most remarkable elucidation through the study of bacteria.

Scientific agriculturists are generally agreed that one of the most important plant-foods in the soil is *nitric acid;* indeed they inform us that if a soil were utterly destitute of this material it would be incapable of growing the barest pretence of a crop, *either of corn, or of roots, or of grass,* even if the soil were in other respects of the most superb texture, however favourably it might be situated, however well drained, tilled, and supplied with the purely mineral ingredients of plant-food, such as *potash, lime,* and *phosphoric acid.*

Yet, notwithstanding the commanding importance of this substance nitric acid to vegetation, it is present in ordinary fertile soils in but little more than homœopathic doses.

These facts are gathered from those grand experiments which have during the past half-century been going on at Rothamsted under the direction of Sir John Lawes and Dr. Gilbert, and which have rendered the Hertfordshire farm a luminous centre of the whole agricultural world.

From these experiments it appears that sometimes there is in fertile soil under 1 part, and often under 10 parts, of nitrogen as nitrate per million of soil.

Indeed, in order to detect and estimate these minute quantities, the most refined methods of chemical analysis have to be called into requisition. [Demonstration of the presence of nitric acid in soil by diphenylamine test.]

Now the cause of such minute quantities only of nitric acid being found in soils is due partly to this material being washed away by the rain, and partly to its being so eagerly taken up by plants for the purposes of nutrition; for it has long been known that by suitable means the quantity can be enormously increased if no vegetation is maintained, and the ground properly protected from rain. The soil, in fact, under ordinary circumstances, continuously generates this nitric acid from the various nitrogenous manures which are applied to it, and it is in the form of nitric acid that the nitrogen of manures principally gains access as nutriment to the plant.

It was in the year 1877 that two French chemists, Schlœsing and Müntz, showed that this power of soils to convert the nitrogen of nitrogenous substances into nitric acid was due to low forms of life—to micro-organisms or bacteria. The proof which they furnished of this statement was of a very simple character, and consisted essentially in demonstrating that this production of nitric acid, or process of *nitrification*, as it is generally called, is promptly inhibited or brought to a standstill by all those materials which have the property of destroying micro-organisms, and which we call *antiseptics;* whilst similarly the process is stopped by heat and other influences which are known to be fatal to life in general.

These results of Schlœsing and Müntz were confirmed and greatly extended in this country by Mr. Warington and Dr. Munro, but although the vital nature of the process was fully established, little practical advance was until recently made in the identification or isolation of the particular bacteria responsible for this remarkable and invaluable transformation.

In 1886, however, a very important step was made by Dr. Munro, who showed that this process of nitrification could take place in solutions practically destitute of organic matter, or, in other words, that the vital activity of the bacteria of nitrification could be maintained without nutriment of an organic nature.

In 1885, I had myself already established the fact that some micro-organisms can actually undergo enormous multiplication in ordinary distilled water:—

Multiplication of Micro-organisms in Distilled Water.[1]

Hours after introduction of micro-organisms.	Number of micro-organisms found in 1 c.c. of water.
0	1,073
6	6,028
24	7,262
48	48,100

In taking up the subject of nitrification in conjunction with my wife in the autumn of 1886, I determined to avail myself of this remarkable property of the nitrifying organisms to grow in the absence of organic matter, thinking that in this way it would be possible to achieve a separation of the nitrifying organisms from other forms which can only grow if organic food materials are supplied to them.

Proceeding on these lines, we have carried on the process of nitrification over a period of upwards of four years without the nitrifying organisms being supplied with any organic food materials whatsoever:—

Composition of Solution employed for Nitrification.

Ammonium chloride...	·5 grm.	In 1000 c.c. of distilled water.
Potassium phosphate	·1 ,,	
Magnesium sulphate...	·02 ,,	
Calcium chloride	·01 ,,	
Calcium carbonate	5·0 ,,	

In a solution of this composition the process of nitrification was carried on over a period of upwards of four years, as indicated in the table on p. 137.

In carrying on this series of experiments it was soon evident that although a number of forms foreign to the nitrification process were being eliminated, there were still some remaining alongside of the nitrifying organisms, or, in other words, that a pure culture of the nitrifying organisms had not been obtained. From various considerations, however, we came to the conclusion that the nitrifying organisms probably differed from the other forms which were still present along with them in being unable to grow on the common cultivating medium employed by bacteriologists, and known as gelatin-peptone.

[1] Proc. Roy. Soc., 188

Experiments on Continuous Nitrification in Mineral Solutions.

Generation	Date of inoculation.	Quantity taken for inoculation.	Date when nitrification first observed.
I.	9 5 1887	Original garden soil	20 5 1887
II.	25 6 1887	3 needle-loops from I.	30 6 1887
III.	1 7 1887	,, II.	7 7 1887
IV.	14 7 1887	,, III.	23 7 1887
V.	25 7 1887	,, IV.	17 8 1887
VI.	26 8 1887	,, V.	1 10 1887
VII.	3 10 1887	1 needle-loop from VI.	7 10 1887
VIII.	7 10 1887	1 needle-point from VII.	17 10 1887
IX.	17 10 1887	,, VIII.	29 10 1887
X.	7 11 1887	,, IX.	30 11 1887
XI.	1 12 1887	,, X.	15 12 1887
XII.	16 12 1887	,, XI.	13 1 1888
XIII.	28 1 1888	,, XII.	20 2 1888
XIV.	29 2 1888	,, XIII.	5 4 1888
XV.	7 4 1888	,, XIV.	27 4 1888
XVI.	30 4 1888	,, XV.	10 5 1888
XVII.	12 5 1888	,, XVI.	26 5 1888
XVIII.	19 7 1888	,, XVII.	3 9 1888
XIX.	3 9 1888	,, XVIII.	1 10 1888
XX.	11 10 1888	,, XIX.	20 11 1888
XXI.	24 11 1888	,, XX.	26 2 1889
XXII.	26 2 1889	,, XXI.	4 5 1889
XXIII.	28 6 1889	,, XXII.	18 10 1889
XXIV.	4 11 1889	,, XXIII.	17 12 1889
XXV.	27 12 1889	,, XXIV.	25 4 1890
XXVI.	16 5 1890	,, XXV.	2 7 1890
XXVII.	15 7 1890	,, XXVI.	30 1 1891
XXVIII.	3 3 1891	,, XXVII.	28 5 1891

The separation from these foreign forms was ultimately effected by enormously diluting one of these nitrifying solutions, and then taking out small portions of this diluted material and introducing each of these portions into separate ammoniacal solutions. In some of these nitrification was established, in others not, whilst amongst those in which nitrification *was* established, some contained organisms which grew upon gelatin, whilst one refused to give any growth on the gelatin at all, although it was seen under the microscope to contain abundantly bacteria of the form shown in the diagram. [Lantern-slide of nitrifying bacillococcus (Frankland).]

These results, which were published in March 1890, were followed in about a month by a communication in the *Annales de l'Institut Pasteur*, by M. Winogradsky, who had also separated a very similar, if not identical, nitrifying organism, and a few months later again a similar separation was made by Mr. Warington.

But these discoveries had not completely unravelled the problem of nitrification, for the organisms separated in these three independent investigations possessed only the property of *converting ammonia into nitrous and not into nitric acid.* The nitrous acid is an intermediate body, which curiously is rarely found excepting in very minute quantities in soil. The changes will be more clearly understood by reference to the chemical equations :—

$$(1)\quad \underset{\text{(Ammonia)}}{NH_3} + \underset{\text{(Oxygen)}}{3O} = \underset{\text{(Water)}}{H_2O} + \underset{\text{(Nitrous Acid)}}{NHO_2}$$

$$(2)\quad \underset{\text{(Nitrous Acid)}}{NHO_2} + O = \underset{\text{(Nitric Acid)}}{NHO_3}$$

The organisms separated by Winogradsky, by Warington, and by myself, possessed only the property of effecting the first of these changes, they were absolutely destitute of the power of bringing about the second.

Now, the curious thing is that the first of these changes is by far the most difficult to accomplish by *purely chemical means*, whilst the second can be brought about with the greatest facility. [Demonstration of addition of acid permanganate to solution of ammonium sulphate, colour not discharged.] [Demonstration of addition of acid permanganate to solution of potassium nitrite, colour discharged.]

Thus the potassium permanganate has no action on the ammonia, whilst the nitrite it oxidizes to nitrate.

In order to bring about the first change, we have to employ one of the most powerful oxidizing agents known to chemists, viz. ozone. [Demonstration : ozone from a Siemens tube was passed through strong solution of ammonia ; the production of nitrous and nitric acids was exhibited by the formation of white fumes, as well as by the sulphanilic acid and diphenylamine tests.]

We thus see that the power of oxidation possessed by our nitrifying organism is altogether unique, and does not find its parallel amongst purely chemical agents of oxidation. *But how then is the nitric acid found in the soil produced, when these organisms yield only nitrous acid?*

At the time when I found that the organism which I had separated produced nitrous acid exclusively, I pointed out that it was doubtless explicable on one of two hypotheses : (1) that nitrous and nitric acids are produced by totally distinct organisms ; or (2) that the same organism produces the one or the other according to the conditions under which it is growing.

More recent researches of Winogradsky have shown that the first of these two alternative hypotheses is the correct one, for, by making cultivations of soil in a solution containing nitrous acid and no ammonia, Winogradsky has succeeded in isolating a micro-organism which possesses the power of converting nitrous acid into nitric acid, but has no power of attacking ammonia. [Lantern-slide of nitric ferment (Winogradsky).]

This second organism or *nitric ferment*, as we may call it, resembles in its activity the purely chemical oxidizing agent—*potassium permanganate*—which, as we have seen, has no action on ammonia, but readily converts nitrous into nitric acid.

The process of nitrification in the soil now becomes intelligible in its entirety. It is the work of two independent organisms, the first of which converts ammonia into nitrous acid, whilst the second transforms into nitric acid the nitrous acid produced by the first.

There is a point in connection with the distribution of nitric acid in nature which is exceedingly remarkable, and which forces itself upon the attention of every student of the process of nitrification. Although nitric acid is generally so scantily present in the soil, there is one notable exception to this rule, for in the rainless districts of Chili and Peru there are found immense deposits of nitrate of soda, or Chili-saltpetre, as it is called, which would appear to represent the result of a gigantic nitrification process in some previous period of the earth's history. The vast quantities of this material which occur in these regions of South America can be gathered from the fact that its exportation has for years been going on at the rate indicated by the following figures :—During the first six months of 1890 there were brought to the United Kingdom 90,000 tons, and to the European continent 480,000 tons.

From the presence of such altogether enormous quantities, one is almost tempted to hazard the suggestion that in this particular region of the earth, under some special circumstances of which we know nothing, the nitrifying organisms must have been endowed then and there with very much greater powers than they possess to-day, and it is particularly noteworthy that in a recent examination of soils from nearly all parts of the earth, one coming from Quito, and therefore not far distant from these nitrate fields, was found to possess the power of nitrification in a degree far beyond that exhibited by any other soil hitherto experimented with. Is it not possible, perhaps, that we have in these vigorous nitrifying organisms of the soil of Quito, the not altogether unworthy descendants of the Cyclopean race of nitrifying bacteria, which must have built up the nitrate wealth of Chili and Peru, and thus countless ages ago founded the fortunes of our nitrate kings of to-day?

But these nitrifying organisms have also assisted in teaching us a highly important lesson in connection with the maintenance of life.

The facts which I have already referred to concerning the multiplication of micro-organisms in distilled water, and the continuation of the nitrification-process over a period of four years in purely mineral solutions, are strong presumptive evidence in favour of these bacteria being able to gain a livelihood in the entire absence of organic food-stuffs. I refrained, however, from promulgating such a revolutionary doctrine until I should have had an opportunity of repeating these experiments with materials in which the absence of even the merest traces of organic matter had been assured, for, as chemists well know, even distilled water may contain traces of organic matter.

Such a rigid proof as I had contemplated has, however, in the meantime been attempted by M. Winogradsky, also in connection with his experiments on nitrification, and he has indeed found that the nitrifying organisms flourish, multiply, and actually build up living protoplasm in a solution from which organic matter has been most rigorously excluded. Now this living protoplasm in the experiments in question must have been elaborated by these bacteria from carbonic acid as the source of the protoplasmic carbon, and from ammonia and nitrous or nitric acids as the source of the protoplasmic nitrogen. If these experiments are correct, and they were undoubtedly performed with great skill and much caution, they are subversive of one of the fundamental principles of vegetable physiology, which denies to all living structures, save those of green plants alone, the power of building up protoplasm from such simple materials.

I had occasion to mention in connection with these nitrifying organisms that they refuse to grow on the ordinary solid cultivating media employed by bacteriologists, a fact which presents a great obstacle to their isolation in a state of purity, for it is just by means of these solid culture media that micro-organisms are most easily obtained in the pure state.

This difficulty has, however, been overcome in a most ingenious manner, originally devised by Prof. Kühne, in which the solid medium is wholly composed of mineral ingredients, the jelly-like consistency being obtained by means of silica. [Demonstration of preparation of silica-jelly, consisting of ammonia sulphate, potassium phosphate, magnesium sulphate, calcium chloride, magnesium carbonate, and dialyzed silicic acid.]

Fixation of Free Nitrogen by Plants.

But whilst the study of the bacteria giving rise to nitrification has thus led to the subversion of what was regarded as a firmly established principle of vegetable physiology (viz. *the incapacity of any but green plants to utilize carbonic acid in the elaboration of protoplasm*), the same science has received another shock, of perhaps equal if not greater violence, through researches which have been carried on with other micro-organisms flourishing in the soil.

For nearly a century past agricultural chemists and vegetable physiologists have been debating as to whether the free nitrogen of our atmosphere can be assimilated or utilized as food by plants. This question was answered in the negative by Boussingault about fifty years since; the problem was again attacked by Lawes, Gilbert, and Pugh about thirty years ago, and *their* answer was also in the negative. In the course, however, of their continuous experiments on crops, Lawes and Gilbert have frequently pointed out that whilst the nitrogen in most crops can be accounted for by the combined nitrogen supplied to the land in the form of manures and in rain water, yet in particular *leguminous* crops, such as peas, beans, vetches, and the like, there is an excess of nitrogen which cannot be accounted for as being derived from these obvious sources. The origin of this excess of nitrogen in these particular crops they admitted could not be explained by any of the orthodox canons of the vegetable physiology of the time. The whole question of the fixation of atmospheric nitrogen by plants was again raised in 1876 by a very radical philosopher, in the person of M. Berthelot, whilst the most conclusive experiments were made on this subject by two German investigators, Prof. Hellriegel and Dr. Wilfarth, who have not only shown that this excess of nitrogen in leguminous crops is obtained from the atmosphere, but also that this assimilation of free nitrogen is dependent upon the presence of certain bacteria flourishing in and around the roots of these plants, for when these same plants are cultivated in sterile soil the fixation of atmospheric nitrogen does not take place. Moreover, the presence of these microbes in the soil occasions the formation of peculiar swellings or tuberosities on the roots of these plants, and these tuberosities, which are not formed in sterile soil, are found to be remarkably rich in nitrogen, and swarming with bacteria. [Lantern-slide of nodules on roots of sainfoin (Lawes and Gilbert).]

Extremely important and instructive in this respect are the experiments of Prof. Nobbe, who has not only confirmed the results mentioned, but has endeavoured to investigate the particular bacteria which bring about these important changes, and he has indeed succeeded in showing that in many cases each particular leguminous plant is provided with its particular micro-organism which leads to its fixation of free nitrogen. Thus he found that if pure cultivations of the bacteria obtained from a pea-tubercle were applied to a pea plant there was a more abundant fixation of atmospheric nitrogen by this pea-plant than if it was supplied with pure cultures of the microbes from the tubercles of a lupin or a robinia; whilst similarly the robinia was more beneficially affected by the application of pure cultures from robinia-tubercles than by those from either pea-tubercles or lupin-tubercles. [Lantern-slides exhibiting Nobbe's experiments on pea and robinia.]

This subject of the source of nitrogen in leguminous plants has again been taken up by Sir John Lawes and Dr. Gilbert at Rothamsted, and their recent results fully confirm the observations of these foreign investigators that it is partially derived from the free atmospheric nitrogen through the agency of bacteria in the soil.

To micro-organisms again, then, we must ascribe the accomplishment of this highly important chemical change going on in the soil, although it has not hitherto been so fully illuminated as the process of nitrification.

Selective Action of Micro-organisms.

Any of the ordinary plants and animals with which we are familiar may be regarded as analytical machines, and we ourselves, without any knowledge of chemistry, are constantly performing analytical tests; thus we can all distinguish between sugar and salt by the taste, between ammonia and vinegar by the smell, whilst by a more elaborate investigation we distinguish, for instance, between the milk supplied from two different dairies by ascertaining on which we or our children thrive best. In fact, such analytical or selective operations are amongst the first vital phenomena exhibited by an organism on coming into this world. It is, however, particularly surprising to find this analytic or distinguishing capacity developed in an extraordinarily high degree amongst micro-organisms. From the power which we have seen that some possess of flourishing on the extremely thin diet to be found in distilled water, we should be rather disposed to think that caprice would be the very last failing with which they would be chargeable. As a matter of fact, however, the perfectly unfathomable and inscrutable caprice of these minute creatures is amongst the first things with which the student of bacteriological phenomena becomes impressed. Let me call your attention to a striking example of this which I have recently investigated.

I have here two substances, which have the greatest similarity:—

	MANNITE.	DULCITE.
Occurrence.	Numerous plant-juices ...	Ditto, but less frequently.
Taste.	Sweet	Ditto, but less so.
Melts.	166° C.	188° C.
Crystalline form.	Large rhombic prisms	Large monoclinic prisms.

Not only, however, do these two substances possess such a strong external resemblance to each other, but in their chemical behaviour also they are so closely allied that one formula has to do duty for both of them, for so slight is the difference in the manner in which their component atoms are arranged that chemists have not yet been able with certainty to ascertain in what that difference consists. Under these circumstances it would have been anticipated that bacteria would be quite indifferent as to which of these two substances was presented to them, and that they would regard either both or neither as acceptable. But such is by no means the case; some micro-organisms, like ordinary yeast, have *no action upon either*, whilst *others will attack mannite, leaving dulcite untouched, others again, being less discriminating, attack both*: representatives of a fourth possible class *which would act upon dulcite but not upon mannite* are as yet undiscovered. [Lantern-slide and plate-culture of *B. ethaceticus.*]

This bacillus, I have recently shown, has the property of breaking down the mannite molecule into alcohol, acetic acid, carbonic anhydride, and hydrogen, but leaves the dulcite molecule untouched.

More recently I have, in conjunction with my late assistant, Mr. Frew, succeeded in obtaining a micro-organism which decomposes both mannite and dulcite into alcohol, acetic and succinic acids, carbonic anhydride, and hydrogen. [Lantern-slide and plate-culture of *B. ethacetosuccinicus.*]

Optically Active Substances.

But these are by no means the ultimate limits to which the selective or discriminating powers of micro-organisms can be pushed, for although mannite and dulcite are extremely similar substances, they are not chemically identical. We are acquainted, however, with substances which, though chemically identical, are different in respect of certain physical properties, and are hence known as *physical isomers*. It is in explanation of this physical isomerism that one of the most beautiful of chemical theories was propounded by Lebel and Van 't Hoff in 1874, and which remains unsupplanted to the present day.

This theory depends upon taking into consideration the dissymmetry of the molecule which is occasioned by the presence in it of a carbon-atom which is combined with four different atoms or groups of atoms, and is most easily intelligible from an inspection of these two models. [Demonstration of tetrahedral models of asymmetric carbon-atom.]

This molecular dissymmetry is specially exhibited in the crystalline form of such substances, and in their action upon polarized light.

The molecule arranged according to the one pattern has the property of turning the plane of polarization in one direction, whilst the molecule arranged according to the other pattern has invariably the property of turning the plane through precisely the same angle in the opposite direction. The molecular dissymmetry ceases when two such molecules combine together, the resulting molecule having no action on polarized light at all.

The interest of these phenomena in connection with micro-organisms lies in the fact that they are sometimes possessed of the power of discriminating between these physical isomers. Although this remarkable property was demonstrated years ago by Pasteur in respect of the tartaric acids, it has only comparatively rarely been taken advantage of. Recently, however, chemical science has been enriched in several instances by successfully directing the energies of micro-organisms in such work of discrimination.

During the past few years no chemical researches have commanded more interest, both on account of their theoretic importance and the fertility of resource exhibited in their execution, than those of Emil Fischer's, which have led to the artificial preparation in the laboratory of several of the various forms of sugar occurring in nature, as well as of other sugars not hitherto discovered amongst the products of the animal or vegetable kingdoms. The natural sugars are all of them bodies with dissymmetric molecules, powerfully affecting the beam of polarized light, but when prepared artificially they are without action on polarized light, because in the artificial product the left-handed and right-handed molecules are present in equal numbers, the molecules of the one neutralizing the molecules of the other, and thus giving rise to a mixture which does not affect the polarized beam either way. By the action of micro-organisms, however, on such an inactive mixture, the one set of molecules is searched out by the microbes and decomposed, leaving the other set of molecules untouched, and the latter now exhibit their specific action on polarized light, an active sugar being thus obtained.

The most suitable micro-organisms to let loose, so to speak, on such an inactive mixture of sugar-molecules, are those of brewers' yeast, which decompose the sugar molecules with formation of alcohol and carbonic anhydride. Their action on these inactive artificial sugars of Fischer's is particularly noteworthy.

One of the principal artificial sugars prepared by Fischer is called *fructose*; it is inactive, but consists of an equal number of molecules of oppositely active sugars called *lævulose*.

One set of these lævulose-molecules turns the plane of polarization to the right, and we may call them *right-handed lævulose*, whilst the other set of *lævulose-molecules* turns the plane of polarization to the left, and we may call them *left-handed lævulose*.

The left-handed lævulose occurs in nature, whilst the right-handed lævulose, as far as we know, does not. Now, on putting brewers' yeast into a solution of the fructose, the yeast-organisms attack the left-handed lævulose molecules and convert them into alcohol and carbonic anhydride, whilst the right-handed lævulose is left undisturbed. The yeast organisms thus attack that particular form of lævulose of which their ancestors can have had experience in the past, whilst they leave untouched the right-handed lævulose molecules, which, being a new creation of the laboratory, they have no hereditary instinct or capacity to deal with.

This selective power is possessed also by other forms of micro-organisms besides the yeasts, which are indeed only suitable for the separatory decomposition of sugars, and by means of bacterial forms a much greater variety of substances can be attacked in this manner. Thus I have recently found that glyceric acid can be decomposed by the *B. ethaceticus*, to which I have already referred this evening.

This glyceric acid is thus represented by chemists :—

$$C_3H_6O_4 \quad \text{or} \quad \begin{array}{c} (CH_2OH) \\ | \\ (H)—C(OH) \\ | \\ (COOH) \end{array}$$

and this should, according to Le Bel and Van 't Hoff's theory, be capable of existing in two physically isomeric forms, as easily shown by our models.

The ordinary glyceric acid known to chemists is, however, quite inactive to polarized light, and must consist, therefore, of a combination in equal molecules of a right-handed and left-handed glyceric acid. Now when the *B. ethaceticus* is put into a suitable solution of the calcium salt of this glyceric acid, it multiplies abundantly, and completely consumes the right-handed molecules of the salt, but leaves the left-handed molecules entirely intact, a powerfully active glyceric acid being thus obtained. [Demonstration of the lævorotary power of solution of new zinc glycerate with projection-polariscope.]

A number of derivatives of this new active glyceric acid have recently been prepared in my laboratory :—

Derivatives of Active Glyceric Acid.

Formula.	Specific Rotation. $[\alpha]_D$
$(C_3H_5O_3)_2$ Ba + $2H_2O$	-9°
$(C_3H_5O_3)_2$ Sr + $3H_2O$	-10
$(C_3H_5O_3)_2$ Ca + $2H_2O$	-12
$(C_3H_5O_3)_2$ Cd + $1\frac{1}{2}H_2O$	-14
$(C_3H_5O_3)_2$ Zn + H_2O	-22
$(C_3H_5O_3)_2$ Mg + H_2O	$-18{\cdot}5$
$C_3H_5O_3$ Na	-16
$C_3H_5O_3$ Am	-20
$C_3H_5O_3$ K	-15
$C_3H_5O_3$ Li	$-20{\cdot}5$
$C_3H_5O_3$ Me	$-4{\cdot}8$
$C_3H_5O_3$ Et	$-9{\cdot}2$
$C_3H_5O_3$ Pr (*n*)	$-13{\cdot}0$

Here again, then, chemistry has been enriched by a number of new compounds, which we owe entirely to the unaccountable caprice of this micro-organism.

Individuality of Micro-organisms.

Although micro-organisms are thus becoming more and more indispensable reagents in the chemical laboratory, essential as they are for the production of many bodies, it is always necessary to bear in mind that by virtue of their vitality their nature is infinitely more complex than that of any inanimate chemicals which we are accustomed to employ. In a chemically pure substance we believe that one molecule is just like another, and hence we expect perfect uniformity of behaviour in the molecules of such a pure substance under prescribed conditions. In a pure cultivation of a particular species of micro-organism, however, we must not expect such rigid uniformity of behaviour from each of the individual organisms making up such a cultivation, for there may be and frequently are great differences amongst them; in fact, each member of such a pure culture is endowed with a more or less marked individuality of its own, and these possible variations have to be taken into consideration by those who wish to turn their energies to account. In fact, experimenting with micro-organisms partakes rather of the nature of legislating for a community than of directing the inanimate energies of chemical molecules. Thus frequently the past history of a group of micro-organisms has to be taken into account in dealing with them, for their tendencies may have become greatly modified by the experiences of their ancestors.

Of this I will give you an instance which has recently come under my observation :—

Here is a bacillus, which has the property of fermenting calcium citrate; I have found that it can go on exerting this power for years. On submitting this fermenting liquid to plate-cultivation, we obtain the appearances which you see here. [Lantern-demonstration of plate-culture of bacillus which ferments calcium citrate.]

If one of these colonies be transferred to a sterile solution of calcium citrate, it invariably fails to set up a fermentation of the latter, the bacillus having thus by mere passage through the gelatin-medium lost its power to produce this effect. If, however, we take another similar colony and put it into a solution of broth containing calcium citrate, fermentation takes place; on now inoculating from this to a weaker solution of broth containing calcium citrate, this also is put into fermentation, and by proceeding in this manner we may ultimately set up fermentation in a calcium citrate solution which absolutely refused to be fermented when the bacilli were taken directly from the gelatin-plate.

Phenomena of this kind clearly indicate that there may be around us numerous forms of micro-organisms of the potentiality of which we are still quite ignorant. Thus, if we were only acquainted with the bacilli I have just referred to from gelatin cultures, we should be quite unaware of their power to excite this fermentation of calcium citrate, which we have only been enabled to bring about by pursuing the complicated system of cultivation I have indicated. It is surely exceedingly probable, therefore, that many of the micro-organisms with which we are already acquainted may be possessed of numerous important properties which are lying dormant until brought into activity by suitable cultivation.

This power of modifying the characters of bacteria by cultivation is, I venture to think, of the highest importance in connection with the problems of evolution, for in these lowly forms of life, in which, under favourable circumstances, generation succeeds generation in a period of as little as 20 minutes, it should be possible through the agency of selection to effect metamorphoses, both of morphology and physiology, which would take ages in the case of more highly organized beings to bring about.

We hear much about the possibility of altering the human race through training from the enthusiastic apostles of education, but even the most sanguine cannot promise that any striking changes will be effected within several generations, so that such predictions cannot be tested until long after these reformers have passed away. In the case of micro-organisms, however, we can study the effect of educational systems consequentially pursued through thousands of generations within even that short span of life which is allotted to us here.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Dr. Peile, Master of Christ's College, has been re-elected Vice-Chancellor for the ensuing academical year.

The examination for the Diploma in Public Health will begin on October 4. Candidates are to send their names to the Registrary by September 27.

Prof. Roy announces a special course in Bacteriology, to be given during the long vacation by Mr. Adami, Mr. Kanthack (one of the Leprosy Commissioners), and Dr. Lloyd Jones, beginning on July 8. It is especially intended for candidates, not necessarily members of the University, for the Diploma in Public Health.

An elaborate scheme for the proposed Mechanical Sciences Tripos has been prepared by a special Syndicate, and appears in the *University Reporter* for May 31. The Tripos follows the main lines of the Natural Sciences Tripos, and seems to be free from the objections which have proved fatal to former schemes.

It is understood that the persons on whom honorary degrees are to be conferred on June 11, in connection with the Chancellor's inauguration, have been for the most part nominated by his Grace. This will perhaps account for the political character of the list, which is, however, partially relieved by the presence on it of General R. Strachey, and Mr. G. W. Hill, late of the office of the *American Ephemeris*, and known among astronomers for his fine work on the lunar theory. Five of the honorary graduates are Fellows of the Royal Society.

The University College of Wales, Aberystwyth, has been admitted to the privileges of a College affiliated to the University. The Mason College of Science, Birmingham, has been associated with the Local Lectures Syndicate in the work of University Extension.

Dr. W. Howship Dickinson, Dr. Bradbury, and Dr. J. F. Payne have been appointed Examiners in Medicine, Dr. W. S. Playfair and Dr. Griffith Examiners in Midwifery, and Messrs. Herbert Page, Frederick Treves, and Howard Marsh Examiners in Surgery.

Notice of opposition to the appointment of Sir R. S. Ball to the Directorship of the Observatory has been given. The grounds stated are that the duties of the Professorship of Geometry and Astronomy should occupy the whole time of the Professor, while the energies of the Director, in view of the recent developments of astronomical science, should be entirely devoted to the work of the Observatory. It is also held to be unwise in these circumstances to refuse the munificent offer of Mrs. Adams to provide £10,000 for the endowment of a separate Director.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 19.—"On the Changes produced by Magnetization in the Length of Iron and other Wires carrying Currents." By Shelford Bidwell, M.A., LL.B., F.R.S.

The changes of length attending the magnetization of rods or wires of iron and other magnetic metals which were first noticed by Joule in 1841, and have in recent years formed the subject of many experiments by the author, have been found to be related to several other phenomena of magnetism. Maxwell has suggested that they sufficiently account for the twist which is produced in an iron wire when magnetized circularly and longitudinally at the same time. The resultant lines of magnetization, as he points out, take a spiral form; the iron expands in the direction of the lines of magnetization, and thus the wire becomes twisted. Prof. G. Wiedemann, however, to whom the discovery of the magnetic twist is due, appears not to be satisfied with this explanation, believing the effect to be caused by unequal molecular friction.

The subject of magnetic twists has been very fully and carefully investigated by Prof. C. G. Knott, and in a paper published last year in the Transactions of the Royal Society of Edinburgh (vol. xxxvi., Part II., p. 485) he indicates many details in which the phenomena of twist closely correspond with those of elongation and retraction. Assuming their essential identity, and noting that "an increased current along the wire affects the points of vanishing twist in a manner opposite to that in which an increased tension affects it," Prof. Knott is "inclined to conclude that the pure strain effects of these influences are of an opposite character." Now, since the magnetic elongation of an iron wire is known to be diminished by tension, the remark above quoted amounts to a prediction that in an iron wire carrying a current the magnetic elongation would be increased. "We know nothing so far," Prof. Knott observes, "regarding the changes of length when an iron wire *carrying a current* is subjected to longitudinal magnetizing forces"; and it was with the object of acquiring some information on this point, and testing Prof. Knott's prediction, that the experiments described in the present paper were undertaken. The results show that it was amply verified, and thus Maxwell's explanation of the twist receives still further corroboration.

The apparatus used and the methods of observation were the same as those described in former papers. Each specimen of wire examined was 10 cm. long, and the indications of the instrument were read to one ten-millionth part of the length.

The wire first used was of soft commercial annealed iron, 0·75 mm. in diameter. The changes of length which it exhibited under the influence of magnetizing forces gradually increased from 13 to 315 C.G.S. units are indicated in the second column of Table I., in which the unit is one-millionth of a centimetre or one ten-millionth of the effective length of the wire.

The experiment described in the last paragraph was repeated while a current of 1 ampere was passing through the wire, the several magnetizing forces employed being made as nearly as possible the same as before by inserting the same resistances successively in the circuit. The results appear in the third column of Table I., and show that the maximum elongation had risen from 11·5 to 14·5 ten-millionths, while the decrement in a field of 315 had fallen from 22·5 to about 17·5.

The current through the iron wire was then increased, by an alteration of the rheostat, to 2 amperes, and, as appears in the last column of the table, there was again a marked increase of the maximum elongation, and decrease of the retraction in a field of 315.

TABLE I.—*Iron Wire, diameter* 0·75 *mm.*

Magnetic field due to coil. C.G.S. units.	Elongations in ten-millionths of lengths.		
	With no current through wire.	With 1 ampere through wire.	With 2 amperes through wire.
13	3	7	
16	6	9	11·5
23	7·5	12	
34	10	14·5	20
40	11·5	14	
50	10	14	20
61	9·5	12	
81	6	9·5	16
97	4	8	
130	0	3·5	8
171	−4	0	
202	9	4	−1
244	13·5		
250	—	·9	−5
315	−22·5		
319	—	18·5	
323	—		13

For the sake of easy comparison, the principal results obtained with this wire are collected in Table II.

TABLE II.—*Iron Wire, diameter* 0·75 *mm.*

Current through iron wire. Amperes.	Maximum elongation in ten-millionths of length.	Retraction in field of 315 C.G.S. units.	Field in which length is unchanged.
0	11·5	22·5	130
1	14·5	17·5	170
2	20	12	200

Similar experiments were afterwards made with nickel and cobalt.

A nickel wire was used, the diameter of which was 0·65 mm. The retractions which it underwent in fields of gradually increasing strength are given in the second column of Table III.

TABLE III.—*Nickel Wire, diameter* 0·65 *mm.*

Magnetic field due to coil. C.G.S. units.	Retractions in ten-millionths of length.		
	With no current through wire.	With 1 ampere through wire.	Difference.
12	8	8	0
15	10	11	−1
19	15	15	0
28	25·5	25	0·5
36	34	33	1
50	50	48	2
69	74	72	2
84	92	92	0
99	113	112	1
119	134	133	1
150	164	162	2
175	178	178	0
209	196	194	2
256	217	215	2
330	241	240	1

The retractions of the wire when carrying a current of 1 ampere, are given in the third column of the table. Remembering that the figures in the second and third columns denote millionths of a centimetre, the close agreement between the two is very remarkable. Such small discrepancies as exist can hardly be entirely accounted for by observational or instrumental errors; they are probably mainly due to the effect of the rise of temperature (2°·6 C.) caused by the current in diminishing the susceptibility of the nickel.

Tension has a large effect upon the magnetic retraction of nickel: it is, therefore, the more remarkable that the action of a current, which operates so markedly upon iron, should in nickel be practically insensible.

The results with no current obtained for a strip of rolled cobalt, the length of which between the clamps was 10 cm., and the cross section 1·82 sq. mm., are given in the first two columns of Table IV., and those with a current of 2 amperes in the third column.

TABLE IV.—*Cobalt Strip, section* 1·82 *sq. mm.*

Magnetic field due to coil. C.G.S. units.	Retraction in ten-millionths of length.		
	With no current through strip.	With 2 amperes through strip.	Difference.
34	1	1	0
50	2	2·5	−0·5
84	4	5	−1
100	6	6	0
119	7·5	8·5	−1
153	11	11·5	−0·5
209	16	16·5	−0·5
331	26	27·5	−1·5

From an inspection of the differences tabulated in the fourth column, it appears that the effect of the current is to increase the retraction very slightly.

According to Rowland the susceptibility of cobalt is *increased* by heating. The small additional retraction indicated when the current was passing was, therefore, no doubt due to the increased susceptibility consequent upon current heating. It may be noted that tension seems to have no material effect upon the magnetic retraction of cobalt.

Summary.

In an iron wire carrying a current, the maximum magnetic elongation is greater, and the retraction in strong fields is less, than when no current is passing. The effect of the current is opposite to that of tension.

The magnetic retractions of nickel and of cobalt are not sensibly affected by the passage of a current through the metals. (Tension considerably modifies the magnetic retraction of nickel, but not that of cobalt.)

"The Human Sacrum." By A. M. Paterson, M.D., Professor of Anatomy in University College, Dundee, St. Andrews University. Communicated by Prof. D. J. Cunningham, D.Sc., F.R.S.

Chemical Society, May 19.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The President announced that the Council had adopted a resolution expressive of the loss the Society and chemists generally had suffered by the death, on May 5, of Prof. von Hofmann. The resolution would be communicated to the family of the deceased, and to the German Chemical Society.—The following papers were read:—The magnetic rotation of compounds supposed to contain acetyl, or of ketonic origin, by W. H. Perkin. The author draws attention to Brühl's determination of the refractive powers of ethyl acetoacetate, which favours a ketonic constitution, and to its magnetic rotation, which was determined some years ago by himself, and which also supports this view. A list is then given of seven supposed acetyl compounds, of which he has ascertained the magnetic rotation, all giving numbers pointing to a ketonic constitution. As such compounds as these behave sometimes as ketonic and sometimes as hydroxy-derivatives, it was thought desirable to examine a larger number of compounds supposed to contain acetyl, or of ketonic origin, between wide limits of temperature. The following were selected: pyruvic acid, levulinic acid (fused and in solution), ethyl acetonedicarboxylate, ethyl acetoacetate, acetylacetone, methylacetylacetone, and ethyl β-amidocrotonate. The last-mentioned four were examined at widely different temperatures. The magnetic rotations of the first five substances agree with a ketonic constitution, though that obtained for ethyl acetonedicarboxylate is rather high. The rotation of acetylacetone is very high, showing it to be an unsaturated or hydroxy-compound, whilst the value obtained for methylacetylacetone stands between the hydroxy and ketonic rotations. At temperatures near 100°, however, these compounds give much lower rotations than when cold, showing apparently that they change into the more stable or ketonic form when heated. The refractive and dispersive powers of these compounds confirm the magnetic rotations. The magnetic rotation and the refractive and dispersive powers of ethyl β-amidocrotonate show it to be an unsaturated compound. —The origin of colour: ii. The constitution of coloured nitro-compounds, by H. E. Armstrong. The author has previously maintained that colour is conditioned by a quinonoid structure in the case of azo-dyes, such as the rosanilines, methylene-blue, &c. This view is clearly seen to be recommending itself to chemists. Nietzki makes reference to the quinonoid character of a number of dye-stuffs, although he does not seek to apply such a view at all generally. The author considers that, in the case of coloured compounds which have been fairly well studied, it is so generally true that a quinonoid formula is applicable, that the reconsideration of the formula of any coloured substance is warrantable if it do not come within the rule. The term "quinonoid" must, however, be understood to include compounds of the type of benzil, and in the case of closed chain compounds, it appears to be essential that at least one of the quinonoid carbon atoms be associated with a dyad radicle, and that the ring itself be unsaturated. The presence of two ortho- or para-carbonyl groups in a saturated ring apparently does not condition colour. Nitro-compounds as a class do not come within the suggested colour-rule. It is well-known, however, that nitro-compounds are not all coloured, many which are commonly described as yellow, being obtained white if prepared with care; from this it follows that the nitro-group does not *per se* condition colour. This is confirmed by a comparison of ortho- and para-nitrophenol. The ortho-compound is intensely yellow, very volatile, and insoluble in water; paranitrophenol is colourless, non-volatile with steam, and fairly soluble in water. Such a difference as this can hardly be ascribed to a mere change in the relative positions of the radicles. The difference is rendered all the more striking when the substances are contrasted with the methoxy-compounds prepared from ortho- and para-nitrophenol. These two substances are colourless, and agree as closely in their general properties as do most isomeric compounds containing the same radicles. It therefore appears justifiable to represent orthonitrophenol by a quinonoid formula—$C_6H_4 : O . NO_2H$, and to term it quinoneorthonitroxime. As only para- and ortho-compounds can have quinonoid formulæ, it would follow that metanitro-derivatives must be colourless; actually, however, metanitraniline has an intense yellow colour, but gives a colourless benzoate. The present view of its constitution therefore requires revision.—The origin of colour. iii. Colour as an evidence of isodynamic change: the existence of isodynamic acids, by H. E. Armstrong. The author applies the colour-rule dwelt on in the preceding paper to the cases of the coloured substances known as paradihydroxyterephthalic acid, dihydroxypyromellithic acid, and the corresponding "diamido" acids. These may be represented as quinonoid compounds, thereby accounting for their being coloured. Such substances as these readily change in type, yielding derivatives which may be colourless owing to conversion into an isodynamic form.—Studies on isomeric change, No. iv: Halogen derivatives of quinone, Part i., by A. R. Ling. Paradichloroquinone on bromination does not yield metadichlorodibromoquinone, as stated by Hantzsch and Schniter, but the normal product, paradichlorodibromoquinone. Contrary to the statement of Levy, this latter substance does not furnish chlorobromanilic acid on treatment with alkali, but a compound of one molecular proportion of chloranilate and two of bromanilate. Metadichloroquinone on bromination at a high temperature yields paradichlorodibromoquinone, but at ordinary temperatures the normal product, metadichlorodibromoquinone is chiefly obtained. A number of new compounds are described.—Halogen derivatives of quinone, Part ii., by A. R. Ling and J. L. Baker. Chlorotribromoquinone is prepared by brominating monochloroquinol and subsequently oxidizing the product. On treatment with alkali, it generally yields a molecular compound of the composition $C_6ClBr(ONa)_2O_2, 2C_6Br_2(ONa)_2O_2 ; 12H_2O$. Trichlorobromoquinone is obtained by brominating trichloroquinone. On treatment with soda, it yields the compound $C_6Cl_2(ONa)_2O_2, 2C_6ClBr(ONa)_2O_2 ; 10\frac{1}{2}H_2O$.—The crystalline forms of the sodium salts of substituted anilic acids, by W. J. Pope. A comparison of the crystallographic dimensions of the sodium salts of the brominated and chlorinated anilic acids referred to in the two preceding papers shows that the crystals possess considerable similarity.—Formation of a hydrocarbon, $C_{18}H_{12}$, from phenylpropionic acid, by F. S. Kipping. When phenylpropionic acid is treated with phosphoric anhydride, a resinous mass is obtained which contains at least three products. The first of these is a hydrocarbon, $C_{18}H_{12}$, which is oxidized by chromic acid mixture to a quinone, $C_{18}H_{10}O_2$. The hydrocarbon yields a dibromo-derivative, $C_{18}H_{10}Br_2$. The second product is a substance which yields a hydrazone of the composition $C_{15}H_{14}N_2$. It may possibly be $C_6H_4 \langle {CH_2 \atop CO} \rangle CH_2$, owing to the fact that it seems to be formed on treating phenylpropionic chloride with aluminium chloride. The third substance produced seems to be an organic derivative of phosphoric acid.—Metallic derivatives of acetylene, by R. T. Plimpton. The silver compounds of acetylene, obtained by several methods, viz. by precipitation of silver acetate or ammoniacal silver nitrate solutions with acetylene, on analysis gave numbers lying between those required for $C_2Ag_2, \frac{1}{2}H_2O$, and $C_2Ag_2 . \frac{1}{3}H_2O$. Aqueous or alcoholic silver nitrate solutions yield precipitates varying in composition from $3C_2Ag_2, 2AgNO_3, H_2O$, and $C_2Ag_2, 2AgNO_3, H_2O$. Silver sulphate solutions gave a product of the composition $2C_2Ag_2, Ag_2SO_4, H_2O$. Mercuric acetate solution gives a white precipitate with acetylene, of the composition $3HgO, 2C_2H_2$, which is not explosive, and does not yield acetylene when treated with hydrochloric acid. In these two properties this substance differs from the precipitate obtained from mercurous acetate.—Isomerism amongst the substituted thioureas, by A. E. Dixon. The author has prepared and examined the properties of isomerides of methylphenylbenzylthiourea and dimethylphenylthiourea.—Note on diastatic action, by E. R. Moritz and T. A. Glendinning. The authors draw the following conclusions from a series of experiments on diastatic action. The attainment of a resting stage in the transformation of starch by diastase by no means shows that the energy of the diastase is exhausted. The energy of the "residual" diastase is, in fact, very considerable, but it is lessened to a marked extent by subjecting the diastase for some time to a temperature exceeding the optimum one for saccharification. When, however, it is not exposed for any length of time to a temperature exceeding the optimum, it appears capable, after transforming a considerable amount of starch, of transforming further quantities to nearly the same point, when such further quantities are added successively and subsequent to the attainment of the resting stage in the preceding transformation.

Zoological Society, May 17.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. W. T. Blanford, F.R.S., exhibited and made remarks on the skin of a Wild Camel obtained by Major C. S. Cumberland in Eastern Turkestan.—In a paper on the geographical distribution of the Land-Mollusca of the Philippine Islands, the Rev. A. H. Cooke showed that the distribution of the different subgenera of *Cochlostyla* affords an interesting clue to the early relations of the various islands of the Philippine group. Regarded from this point of view, the central islands, Samar, Leyte, Bohol, Cebu, Negros, and Panay, with Luzon, were closely related, while Mindoro and Mindanao were remarkably isolated even from their nearest neighbours. An examination of the intervening seas accounted for these phenomena, the depths between the central islands being inconsiderable, while Mindoro and Mindanao are surrounded by very deep water. The Mollusca of the two ridges between the Philippines and Borneo, formed by Busuanga, Palawan, and Balabac, and by the Sulu Archipelago, were partly Philippine, partly Indo-Malay. Two remarkable groups of *Helix*, peculiar to Mindoro, Busuanga, and Palawan, showed relations with Celebes and possibly with New Guinea. The Mollusca of the Batan, Tular, and Talantse Islands were also discussed. Regarded as a whole, the Land-Mollusca of the Philippines were stated to contain: (1) Indo-Malay, (2) Polynesian, (3) indigenous elements, the first decidedly predominating.—A communication was read from Graf Hans von Berlepsch, and M. Jean Stolzmann, containing an account of a collection of birds made by M. Jean Kalinowski in the vicinity of Lima and Ica, in Western Peru. The species of which examples were obtained in the localities were eighty in number. In an appendix an account of previous authorities on the same subject was added.—Mr. G. A. Boulenger gave an account of *Lucioperca marina*, a rare species of fish, originally described by Pallas from the Black Sea and the Caspian, and little known of late years.—A communication from Mr. Oldfield Thomas contained a revision of the Antelopes of the genus *Cephalolophus*, of which eighteen species were recognized as valid. A new species was described as *Cephalolophus jentincki*, from Liberia.—Prof. Bell called attention to the remarkable amount of variation presented by *Pontaster tenuispinis*, numerous examples of which he had been able to examine and compare. He came to the conclusion that several North-Atlantic species, which had been described as distinct, should be regarded as belonging to it.—A communication was read from Mr. H. H. Druce giving an account of the Butterflies of the family Lycænidæ, of the South Pacific Islands. Of thirty-one species mentioned, seven were described as new to science.

Linnean Society, May 24.—Anniversary Meeting.—Prof. Stewart, President, in the chair.—The Treasurer presented his annual report duly audited, and the Secretary having announced the elections and deaths during the past twelve months, the usual ballot took place for new members of Council, when the following were elected: Messrs. E. L. Batters, William Carruthers, Herbert Druce, Spencer Moore, and Dr. D. H. Scott. The President and officers were re-elected. The Librarian's report having been read, and certain formal business having been transacted, the President delivered his annual address, taking for his subject "Commensalism and Symbiosis." On the motion of Dr. R. C. A. Prior, seconded by Mr. Jenner Weir, a cordial vote of thanks was accorded to the President for his able address, with a request that he would allow it to be printed.—The Society's Gold Medal was then formally presented to Dr. Alfred Russel Wallace in recognition of the service rendered by him to zoological science by numerous valuable publications. After Dr. Wallace had replied, the President announced the gift by Dr. R. C. A. Prior of an oxyhydrogen lantern for use at the evening meetings, and moved a vote of thanks to him for his valuable donation. This having been carried by acclamation, the proceedings terminated.

CAMBRIDGE.

Philosophical Society, May 2.—Prof. G. H. Darwin, President, in the chair.—The following communication was made:—Note on the application of the spherometer to surfaces not spherical, by Mr. J. Larmor. The ordinary form of spherometer, with equilateral triangular frame, gives a definite reading, when applied to a surface of double curvature, which corresponds to the arithmetic mean of the principal curvatures at the point; thus on a cylinder it will indicate half the curvature. It may be modified in various ways so as to measure both the principal curvatures by two observations.

May 16.—Prof. G. H. Darwin, President, in the chair.—The following communications were made:—Recent advances in astronomy with photographic illustrations, by Mr. H. F. Newall. A series of photographs was exhibited by the lantern and described, to illustrate recent progress in astronomical photography. The series included some interesting specimens taken with the Newall telescope, in which the object-glass is not specially corrected for photographic purposes.—On the pressure at which the electric strength of a gas is a minimum, by Prof. J. J. Thomson. The author showed that when no electrodes are present, the discharge passes through air at a pressure somewhat less than that due to 1/250 mm. of mercury; the discharge passes with greater ease than it does at either a higher or a lower pressure. Mr. Peace has lately shown that when electrodes are used, the critical pressure may be as high as that due to 250 mm. of mercury; so that as the spark length is altered the critical pressure may range from 250 mm. to 1/250 of a mm. It was pointed out that this involved the possession by a gas conveying the discharge of a structure much coarser than any recognized by the kinetic theory of gases. The author suggested a theory of such a structure, and showed that the theory would account for the influence of spark length and pressure on the potential difference required to produce discharge.—On a compound magnetometer for testing the magnetic properties of iron and steel, by Mr. G. F. C. Searle. An aluminium wire, 30 inches long, suspended vertically by a fibre, carries at the top a magnet fixed at right angles to the wire. The lower end carries a light fork across which a fibre is stretched horizontally. A mirror attached to this fibre carries a magnet at right angles to the fibre. The mirror is thus capable of two independent motions. The specimen of iron is placed in a magnetizing coil near the mirror, and the magnetizing current passes also round a coil placed near the upper magnet. The motion of the mirror is observed by the aid of a spot of light. On gradually increasing and diminishing the current, the spot traces out the well-known hysteresis curves.

EDINBURGH.

Royal Society, May 16.—Sir Douglas Maclagan, President, in the chair.—The Astronomer-Royal for Scotland exhibited a stellar photograph, by Dr. Gill, of the Cape Observatory.—Dr. W. Peddie read a note on the law of transformation of energy and its applications. A generalization of the second law, applicable to forms of energy other than heat, was shown, by special examples, to lead to results already deduced by other methods.—Dr. C. G. Knott and Mr. A. Shand communicated a short note on the volume-effects of magnetization, which was supplementary to results communicated to the Society last year by the former author. When a particular size of iron tube was magnetized, the internal volume was found to undergo the following remarkable series of changes. In very weak fields there was first a slight increase, which, as the field was made stronger, passed through a maximum, then vanished and finally changed sign. From this point (about field 20) up to a field of 120 there was diminution of volume. This diminution was greatest in a field of 64. In fields higher than 120 there was again increase of volume, which attained a maximum about field 400, and fell off very slowly in higher fields. This curious variation of cubical dilatation with strength of field was shown to imply a transverse linear dilatation of (in general) opposite sign to the well-known longitudinal linear dilatation. The amounts, the positions of the maximum points, and of the vanishing points, of these correlated linear dilatations differed sufficiently in detail to produce this peculiar repeated change of sign in the cubical dilatation.—Dr. Hunter Stewart read a paper on the ventilation of schools and public buildings. The first part of the paper contained an account of an investigation as to the presence of organic nitrogenous matter in expired air. Several methods were used for absorbing and collecting these products, *e.g.* breathing through strong sulphuric acid, condensing the moisture from the breath, &c. The organic matter was determined by the process of Kjeldahl, by which the nitrogen is converted into ammonia. The results showed that each cubic foot of expired air contained on an average 0·01149 milligrams of ammonia as such, and 0·002 milligrams of ammonia derived from organic matter. The water condensed from 10 cubic feet of expired air contained on an average 0·5 milligrams of solid residue which entirely disappeared on ignition. These results, confirmatory of the observations of Hermann and Lehmann, proved that the organic matter in badly ventilated rooms did not come from the breath, but from the skin and clothing of the occupants. Since this must be variable, depending on obvious conditions, Dr. Stewart did not determine it, but relied on the estimation of the carbonic acid and moisture as a measure of the efficiency of the ventilation. The following are some of his results taken as averages:—

Edinburgh Hospitals, with 2000 cubic feet of space per bed—			
	Day	5·5	c.c. CO_2 per 10,000
	Night	5·85	,, ,,
Churches	Highest	63·5	,, ,,
	Lowest	20·0	,, ,,
Schools, with, per child,			
	154 c. ft. space and 9·8 sq. ft. area	9·9	,, ,,
	141 ,, ,, 8·8 ,,	13·3	,, ,,
	116 ,, ,, 7·1 ,,	17·2	,, ,,

All the schools and churches were without mechanical ventilation.—Prof. James Geikie read a paper on the glacial succession in Europe. The deposits which first give evidence of glacial action are generally referred to the Pliocene period. These are the oldest ground moraines of Central Europe, the ground moraine underlying the "lower diluvium" of Sweden, and the deposits of the Weybourne Crag with their Arctic marine fauna. Genial climatic conditions followed this period, with a wide land area, Britain being joined to the continent. Then followed the epoch of maximum glaciation, the Scottish and Scandinavian ice-sheets being continuous. Genial climatic conditions followed, Britain being again continental. Then submergence ensued to the 500-feet level, followed by another glacial epoch in which the Scottish and Scandinavian ice-sheets were again continuous. This was succeeded by genial conditions, Britain being once more joined to the continent. Submergence to the 100-feet level in Scotland followed, and then came Arctic conditions with local ice-sheets, succeeded by temperate conditions and the wide land area, and subsequently by submergence to the 50-feet level. Another cold period followed with local glaciers—the last in Britain.

PARIS.

Academy of Sciences, May 30.—M. d'Abbadie in the chair.—Introduction of M. Guyon, the new member elected in the place of M. Richet.—Observations of the small planets, made with the great meridian instrument of the Paris Observatory during the second and third quarters of the year 1891, by M. Mouchez.—On the propagation of electrical oscillations, by M. H. Poincaré. The disturbance is supposed to be propagated along a thin straight conductor. The enfeeblement of the disturbance is theoretically shown to vanish when the diameter of the conductor becomes indefinitely small.—Another blow to the ascent theory of cyclones, by M. Faye. A discussion of recent observations, showing that cyclones are not produced by convection from the soil, but by disturbances in the general circulation of air in the higher regions.—On the monkey of Montsaunès discovered by M. Harlé, by M. Albert Gaudry. A portion of the mandible of a monkey, containing three teeth, was exhibited, found by M. Harlé, engineer at Toulouse, in the Quaternary of the Haute-Garonne. It shows the greatest similarity with the magot of Gibraltar and Algiers.—Physiological effects of a liquid extracted from the sexual glands, and especially the testicles, by M. Brown-Séquard.—On the relations of the Devonian and Carboniferous formations of Visé, by M. J. Gosselet.—Study of the physical and chemical phenomena under the influence of very low temperatures, by M. Raoul Pictet. The calorific æther waves corresponding to low temperatures are found to traverse all bodies with hardly any resistance. A test-tube filled with chloroform was placed in a nitrous oxide refrigerator at -120°. A thermometer in the tube showed a gradual fall to $-68^\circ{\cdot}5$, when crystallization commenced. On removing the test-tube to a refrigerator at -80°, the temperature indicated by the thermometer *fell rapidly* from $-68^\circ{\cdot}5$ to -80°, while the crystals formed on the walls of the test-tube fused and disappeared. On replacing it into the -120° refrigerator, the temperature rose to $-68^\circ{\cdot}5$, and the crystals reappeared. M. Pictet explains these extraordinary phenomena by supposing his thermometers to have acted more as thermodynamometers than as thermoscopes. While the crystals were forming in the first refrigerator, the radiation from the bulb was neutralized by the latent heat given out by the chloroform in crystallizing, whereas in the warmer refrigerator the crystals did not form, and radiation alone was active. Alcohol and sulphuric ether thermometers were used, which were checked by thermometers containing dry hydrogen at four different pressures.—On rectangular co-ordinates, by M. Hatt.—On the application of the optical properties of minerals to the study of the inclosures in volcanic rocks, by M. A. Lacroix.—On a property common to three groups of two polygons, inscribed, circumscribed, or conjugate to the same conic, by M. Paul Serret.—On the canonical developments in series the coefficients of which are differential invariants of a continuous group, by M. Arthur Tresse.—On the calculation of the coefficient of resistance of air, supposing the resistance proportional to the fourth power of the velocity, by M. de Sparre.—On a means of bringing two non-miscible liquids into intimate contact in definite proportions, by M. Paul Marix. This is done by pouring both liquids into the same vessel at a definite rate, and allowing them to leave it by an orifice in the side. They will escape together in the proportion of their volumes, if the level of the liquid is maintained uniform by a constant supply. The surface of separation is invariably found at the level of the orifice, and if a flattened spout is used, a lamellar arrangement of the liquids is produced, thus giving a large surface of contact.—On a hydro-silicate of cadmium, by MM. G. Rousseau and G. Tite. This is produced by the action of the glass vessel when the solid hydrate of neutral cadmium nitrate is heated to about 300°. On dissolving away the basic nitrate with boiling alcohol, the silicate can be detached from the glass in long scales by hot water. Its formula is $2(CdO, SiO_2) . 3H_2O$.—On the decomposition by heat of ammoniacal pentachloride of phosphorus, nitrochloride of phosphorus, and phosphame, by M. A. Besson.—On the phosphates of strontium, by M. L. Barthe.—The calorific power of pit-coal and the formulæ by means of which its determination is attempted, by M. Scheurer-Kestner.—Mechanical determination of the boiling-points of terminal complex substitution products, by M. G. Hinrichs.—On some reactions of the three amido-benzoic acids, by M. Œchsner de Coninck.—On the composition of chlorocruorine, by M. A. B. Griffiths.—On the antiseptic properties of formaldehyde, by M. A. Trillat.—The nervous system of the Neritidæ, by M. E. L. Bouvier.—On the osteological characters of a male *Mesoplodon Sowerbyensis* recently stranded on the French coast, by M. P. Fischer.—On a new species of *Gammarus* of the Lac d'Annecy, and on the fresh-water Amphipoda of France, by MM. E. Chevreux and J. de Guerne.—Action of various toxic substances on *Bombyx Mori*, by M. J. Raulin.—On the genetic relations of resinous and tannic substances of vegetable origin, by MM. Edouard Heckel and Fr. Schlagdenhauffen.—Researches on the grafting of Crucifers, by M. Lucien Daniel.—Contribution to the study of the toxic effect of the diphtheria bacillus, by M. Guinochet.—Contribution to the knowledge of the Saharian climate, by M. Georges Rolland. A summary of observations made at a meteorological station in the oasis of Ayata, in Southern Algiers. The sparse vegetation found here and there seems to derive its moisture from subterranean sources, whence it ascends by capillary attraction, and from certain deliquescent salts found in the soil which absorb moisture at night.—On a passage in Strabo relating to a treatment of the vine, by M. Ant. Aublez.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—La Distribution de L'Électricité, *Usines Centrales*: R. V. Picou (Paris, Gauthier-Villars).—Travail des Bois: M. Alheilig (Paris, Gauthier-Villars).—Medical Electricity: Drs. Steavenson and Jones (Lewis).—First Report of the U.S. Board on Geographic Names, 1890–91 (Washington).—Smithsonian Report, 1890 (Washington).—Lehrbuch der Zoologie: Dr. R. Hertwig, 2 vols. (Jena, Fischer).—Ziele und Wege Biologischer Forschung: Dr. F. Dreyer (Jena, Fischer).—Key to Arithmetic for Beginners: J. Brooksmith and E. J. Brooksmith (Macmillan).—Transactions of the Sanitary Institute, vol. xii. (Stanford).—Bibliography of the Algonquian Languages: J. A. Pilling (Washington).—A Monograph of the Myxogastres: G. Massee (Methuen).—Popular Readings in Science: J. Gall and D. Robertson (Constable).—Researches on Micro-Organisms, Dr. A. B. Griffiths (Baillière).—Darwin et ses Précurseurs Français, deux. édtn., A. de Quatrefages (Paris, Alcan).—Trattato di Fisico-Chimico secondo la Teoria Dinamica: E. dal Pozzo di Mombello (Milano).

PAMPHLETS.—The Orthoceratidæ of the Trenton Limestone of the Winnipeg Basin: J. F. Whiteaves (Montreal, Dawson).—Ursachen der Deformationen und der Gebirgsbildung: Dr. E. Reyer (Leipzig, Engelmann).

SERIALS.—Journal of the Chemical Society, June (Gurney and Jackson).—Meteorological Record, vol. xi., No. 42 (Stanford).—Quarterly Journal of the Royal Meteorological Society, April (Stanford).—Geological Magazine, June (K. Paul).—Natural History Transactions of Northumberland, Durham, and Newcastle-on-Tyne, vol. xi., Part 1 (Williams and Norgate).—The Yale Review, vol. i., No. 1 (Arnold).—Bulletins de la Société d'Anthropologie de Paris, July to December, 1891 (Paris, Masson).—Archives de Sciences Biologiques publiées par l'Institut Impérial de Médecine Expérimentale à St. Pétersbourg, tome i., Nos. 1 et 2 (St. Pétersbourg).—Engineering Magazine, June (New York).—Himmel und Erde, June (Berlin, Paetel).—Journal of the Straits Branch of the Royal Asiatic Society, June (Singapore).

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