THURSDAY, FEBRUARY 24, 1887

THE OWENS COLLEGE

The Owens College: its Foundation and Growth, and its Connection with the Victoria University, Manchester. By Joseph Thompson. (Manchester: J. E. Cornish, 1886.)

THE future historian of the progress of education in England during the nineteenth century will regard the foundation of the Owens College, Manchester, as an event of the first importance. The idea of establishing, in the midst of our great manufacturing towns, institutions devoted to the higher learning was not new. The experiment had been tried in various forms in Manchester itself, but had always failed. A College of Arts and Sciences was founded in 1783 by some of the leading men in the town and county, but, owing to "a superstitious fear of a tendency of a taste for knowledge to unfit young men for ordinary business, this excellent institution had not a long existence." In 1836 meetings were held, and a scheme was drawn up for the establishment in Manchester of a College for general education. In the spring of 1837 it was proposed to elect a Medical Faculty in connection with the College; but, before another year passed, the scheme was abandoned, as very few pupils came forward.

Institutions which aimed chiefly at the preparation of candidates for the Nonconformist ministry were more successful. The Manchester Academy, and the Lancashire Independent College, founded in 1786 and 1840 respectively, are active now; but while the latter is in close alliance with the Owens College, the former has migrated to London. It was not the desire of business men for culture or for technical education, but a demand on the part of Nonconformist professional men for a training which the tests imposed by the older Universities debarred them from obtaining there, which enabled these institutions to survive when others failed. Nay, more; the strongest argument which George Faulkner brought to bear on his friend John Owens, to persuade him to alter the will by which he had made him his heir and to found a College, was "that as he had such strong prejudices against the tests imposed at the older English Universities, he could enable young men to obtain an education equal to that of the favoured institutions, without these hindrances."

But, whether or no Owens was influenced mainly by a feeling of indignation at an injustice which has now been long removed, his benefaction has produced results even wider than those which have followed the abolition of the tests he disapproved. The Owens College was the first example of the successful establishment in a manufacturing town of an institution which gave to all comers a University education. When Manchester had proved that success was possible, others were not slow to follow where she had led. The Owens College was opened in 1851. For some years it seemed that it was to share the fate of its predecessors. At length the tide turned, and the passing of the Owens Extension College Act in 1870 marked the attainment of assured success. In that year Newcastle established a College of Physical Science, the Yorkshire College was founded in Leeds in 1874, and now no large town considers its educational equipment complete if it cannot point to a "University College" in its midst. The importance of this result can hardly be exaggerated. In the midst of a great democratic movement, it has been practically proved that culture and learning need not be the exclusive property of the few. The provincial Colleges have made it possible for the young artisan to obtain instruction from, and to test his own abilities by contact with, teachers who are masters of the subjects they profess. The Owens College is, no doubt, as far as its day classes are concerned, a middle-class institution. But its authorities have also developed a system of evening lectures, by means of which many a working-man has made his first step upwards from the ranks.

At first, the Council and Staff of the College had to face the difficulties which beset pioneers. The religious difficulty met them at the outset. An early attempt at amalgamation with the Medical School failed. The Professors one and all complained that, through lack of a sound elementary training, their students were unable to profit by the instruction they gave. "The worst that can be said of [the College]," remarked the *Manchester Examiner* of July 20, 1858, "is that it is too good for us. It is out of place here, just as a missionary may be said to be out of his place on the coast of Africa. He offers the Gospel, and the people want Sheffield blades. . . . The crowd rolls along Deansgate, heedless of the proximity of Plato and Aristotle. . . . And where is poor learning all the while? Going through its diurnal martyrdom of bootless enthusiasm and empty benches."

The men who had the fate of the College in their hands were not, however, daunted by cold comfort such as this. Gaps in the Staff were promptly filled up. Principal Scott resigning on account of ill health, his place was filled by Prof. Greenwood, and Mr. Roscoe was selected to fill the vacant Chair of Chemistry. Nor was this confidence misplaced. Almost contemporaneously with these appointments, the dwindling number of students began to increase, and within some half-dozen years the difficulty of preventing failure was followed by the difficulties of providing for success. In 1864 we hear of the "insufficient or unsuitable accommodation furnished by the College buildings." In 1865 Prof. Clifton reported that the percentage of carbonic acid in the air of his lecture-room at the conclusion of a lecture was more than four times the maximum consistent with health. Students of the biological sciences complained of the difficulty of finding admission to well-arranged and complete collections of natural history.

It would take too long to follow step by step the advance of the College, but in reading Mr. Thompson's full account of the way in which each difficulty was overcome, the reader cannot but be struck with the fact that the work of the Council and Staff was essentially that of pioneers. Everything had to be discussed; nothing was determined by precedent. In 1860 it was decided that a Professorship of Physics should be founded, but before this step was taken it was thought necessary to inquire not only whether the students were numerous enough and the College rich enough to warrant the change, but whether a Professorship of Physics was in itself a desirable thing. Professors De Morgan and Stokes were asked for formal written opinions on this knotty point. The new Chair was only established when it was held to have been proved that the field of mathematics and natural philosophy was wide enough for the employment of two labourers in different parts. There can be no doubt that the College was remarkably fortunate in the members both of its Council and of its Senate. The Neilds—father and son Mr. Ashton, Mr. Oliver Heywood, and many others, worked as though their personal interests were all bound up in the success of John Owens' bequest. They succeeded in filling the Chairs with men of the most brilliant abilities. To mention only some of those whose connection with the College has now ceased, it is evident that an institution which has within a few years commanded the services of men like Sir Henry Roscoe and Professors Frankland, Clifton, Jevons, Jack, and Gamgee, must have deserved the success it has won.

Nor is it uninstructive, regarding the Owens College as the pioneer in a great movement, to observe how largely that movement has been and is being directed by men who themselves owe much to the Manchester institution. By glancing only at the list of those who have held the office of demonstrator in the physical or chemical laboratories, or of lecturer on mathematics, we observe that the Professorships of Physics in the Mason College, Birmingham ; of Chemistry in Anderson's College, Glasgow, the Yorkshire College, Leeds, the College of Physical Science at Newcastle-upon-Tyne, and the Firth College, Sheffield ; and the Professorships both of Chemistry and Physics in the Normal School of Science, South Kensington, and in University College, Dundee, are or have been held by *alumni* of the Owens College.

When once the College began to grow, it grew rapidly. The change wrought in fifteen years was remarkable. Besides the establishment of numerous new professorships, the Manchester Natural History and Geological Societies handed over their collections to the College as the recognised centre of scientific learning in Manchester. The College and the Medical School were fused into one institution. The handsome buildings in Oxford Road were erected upon land, and partly also with funds, furnished by an Extension Committee, which numbered among its members many of the best-known men in the town, and of which Dr. Watts, whose death Manchester has recently had to deplore, was secretary.

When this was accomplished, the College proceeded to claim the status and powers, as it had already proved its capacity for doing the work, of a University. This question affected interests other than those of Manchester itself. The Yorkshire College, Leeds, then very recently founded, and immature, had sufficient faith in its own future to claim a share in determining the conditions on which a new University was to be established in the North of England. This claim was at first enforced by a formal opposition to the Owens College scheme, on certain specified grounds. Whether a Leeds historian would agree with Mr. Thompson that the opposition "was not based upon accurate knowledge" may be open to question. It may be that the mistake was on the other side, and that the Owens College authorities had not as yet fully recognised the magnitude of the movement to which they themselves had given so great an impulse. However this may be, the controversy seems to have been conducted with fairness and good temper, and to have resulted in an agreement which left none but kindly feelings behind. The Council of the Owens College received satisfactory assurances that their Leeds friends did not desire to share the advantages to be conferred by the Charter of the University till they had made their College worthy of representing it in Yorkshire. On the other hand, they conceded the demand of Yorkshire that the name of the University should not be that "of a town or of any person whose claims to such distinction are merely local." A compromise was arrived at on the other point to which importance was attached. Leeds desired that the Governing Body of the University should be separate and distinct from that of the Owens College, and that it should have power "to incorporate the Owens College and such other institutions as may now or hereafter be able to fulfil the conditions of incorporation laid down in the Charter." This condition was agreed to, with the modification that the Owens College should be named in the Charter as the first College of the University, and that thus its incorporation should be simultaneous with and not posterior to the foundation of the University itself. Finally, a joint deputation from Lancashire and Yorkshire petitioned the Crown in favour of the establishment of the new University. The Charter was granted in 1880. The Owens College was constituted the first College of the University, and though the Yorkshire College has not yet joined it, University College, Liverpool, has recently been admitted as the second member of the federation.

Mr. Thompson's work appropriately ends with the flattering tribute paid by his fellow-citizens to Sir Henry Roscoe by his election as Member of Parliament for one of the divisions of Manchester, and with the expression of the regret of the Council at the severance of his connection with the College. The success of the Owens College is due to no one man, but to no one man more than to Sir Henry Roscoe. His withdrawal may fitly mark the termination of the period of struggle with initial difficulties. The main work of organisation is over. The chief outlines of the scheme for bringing industry into contact with culture and with technical education are drawn. It remains for the Owens and her sister Colleges to fulfil the task on which they are now fairly embarked.

We believe it is not unlikely that in carrying on their work the authorities of the Victoria University may find it necessary to appeal to the Government for a contribution towards the University funds. It will of course be easy to say that as Manchester and Liverpool have done so much they may be left unaided to do more. In forming an opinion upon this question it will be well for the public to remember that, whereas the Universities or Colleges in Edinburgh, Glasgow, Aberdeen, St. Andrews, Aberystwith, Bangor, Cardiff, and the Queen's Colleges in Ireland, receive subventions from the State which amount in all to between 40,000*l.* and 50,000*l.* per annum, English higher education in provincial towns has been entirely provided by unselfish private enterprise, with some assistance in Newcastle from the University of Durham, and elsewhere from the Clothworkers' Company and others of the City Guilds. As far as help from Parliament is concerned, England as usual has to find its share of the money and reaps none of the advantage. It is surely not too much to hope that, if 8000*l.* a year is allotted from the public funds to Colleges which supply the wants of Aberystwith and Bangor, it will not be considered impolitic to help from the National Exchequer the magnificent and national work which has been and is being done in the North of England.

But to return to the book before us. It is fortunate that while the memory of the men who initiated the undertaking is still fresh, and while most of those who carried it out are still with us, an historian such as Mr. Thompson has been found for the Owens College. He has given, not merely the public story of the institution, but short histories of many of those who were closely connected with it and who have now passed away. He has evidently had access to authentic documents and other sources of accurate information, and he has produced a work which will be read with interest by many who have in the past known but little of the Owens College and its founders.

ANDERSON ON HEAT AND WORK

On the Conversion of Heat into Work. By W. Anderson, M.Inst.C.E. (London: Whittaker and Co., and George Bell and Sons, 1887.)

VERY few modern books on Engineering contain what can truly be called accurate science; one of whose special characteristics is the use of each term *in one definite sense only*. In other words, take at random a work on any branch of Engineering, and you find, in every page, more than one sentence which, if it be read as a scientific statement, is simply inaccurate. Of the exceptional works the majority consist of those written by the late Prof. Rankine. He seems to have left no successor, so far as this department of applied science is concerned; and the book before us strongly supports the notion. It gives, in a succinct but comprehensive form, an introduction to the modern Dynamical Theory of Heat, treated almost entirely from the practical Engineer's point of view. It is obviously written by a man who knows his subject, and it is therefore presumably written in terms intelligible to those for whom it is designed. It thus affords a good opportunity of making some further remarks upon the strange line of separation which has unfortunately been drawn between the vocabularies (or, rather, the dictionaries) of Pure and of Applied Science. In using this opportunity, for the purpose stated, we do not attack the present work in particular; we attack the mass of works on Engineering, of which it is a high-class specimen.

From the purely scientific point of view there are two prominent faults in the majority of such works as that before us. The first is the habitual use of a special "vernacular"; not so outrageous, perhaps, as "pidgin" English, but quite on a par with a "wire," a "cable," an "aniline," and such-like monstrosities of recent American origin. Were the words of this vernacular different from those of strict science, our only complaint against their use would be that we should have to learn what would be practically a new language before we could read an Engineering book. But they are, in the main, the same words; and yet each stands for other than the usually accepted meaning. Thus we constantly find pressure given as so many tons per square inch (sometimes the word "square" is omitted). Now, tons per square inch, or pounds per square foot, refer to matter and not to force. They measure, in fact, what is called surface-density. This is altogether "most tolerable, and not to be endured."

The second fault is more grave. It consists in the fundamental misuse of well-settled scientific terms, which the author of an Engineering book usually perpetrates whenever (for a moment) he deserts his vernacular and passes from the applied to the pure part of his subject. We remark in passing that, in the very first page, our author speaks of Mayer's EXPERIMENTAL demonstration of the equivalence of heat and work! This shows how deep a root has been taken by the extravagant laudations of Mayer, which were so common twenty years ago, but which have long since been thoroughly exploded.

Now, to faults of the first class mentioned above. We quote only a few of the more racy passages we had marked; and here, as in the subsequent examples, we introduce (to save comment) Italics where they seem desirable.

"Accelerating forces, *that is* forces acting steadily for a time." This may be the Engineer's vernacular, but it has no necessary connection with the use, in English, of the term "accelerating force."

"Dividing (3,942,400 *foot-pounds* per minute) by 33,000 *foot-pounds*, we get 119·4 *horse-power!*" Put this in the form "dividing 500*l.* a year by 50*l.* we get 10*l.* a year," which contains essentially the same absurdity, and we can scarcely fancy that our author would have let it stand; although in its above form it is put as Engineers too commonly put it.

"The heavenly bodies, *moving at uniform velocities for ever* are instances of *potential* energy." This is the Engineer's way of saying that since there is no change of kinetic, there can be no change of potential, energy.

"When we speak of perfectly elastic substances, we do not mean those which, like india-rubber, have a great range of elasticity." But, though this is true of Engineers, it is not true of purely scientific men. Think of air, for instance.

"Endowed with energy competent to produce the *sensation* of 100° Fahr. of *heat*." Here the Engineers pick a quarrel with the Physiologist as well as with the Physicist.

As explained above, all this is merely the licence which practical men take with scientific terms. As the book is written for such men, perhaps we ought not to complain. But the faults of the second class, some of which we proceed to give, can only be explained by the practical men's using scientific words in a wrong sense. From the following, and others too numerous to be quoted, a new science (!) could be founded, having nothing in common with that which Galilei and Newton have handed down to us, (of course on the supposition that all the words employed are to be taken as they are understood in pure science.)

"Hence the *potential energy* of each gallon of water is

1/330 of a *horse-power!*" Our author would surely have thought twice before writing "the *distance* from London to York is 200 *miles per hour.*" But this, to which we invite his careful attention, would have involved no greater blunder.

"If the bodies are elastic . . . , the *whole* of the *energy* of the striking body is expended in producing *motion* in the body *struck.*" After this it will not, perhaps, surprise the reader to find that we are furnished with a calculation of "the total *heat from absolute zero* resident in exploded powder, at an atmospheric temperature of 50°, or 510° absolute."

The work may be made, even as a whole, thoroughly useful to those habituated to the persistent inaccuracies of the "vernacular":—but, to effect this, it must be carefully purged of statements analogous to the three last-made quotations. P. G. T.

A FIELD NATURALIST IN EASTERN BENGAL

Letters on Sport in Eastern Bengal. By Frank B. Simson, Bengal Civil Service, retired. (London: R. H. Porter, 1886.)

THIS book is essentially a record of sporting scenes, and the author has ostensibly written it for the purpose of giving instruction in the art of shooting and hunting wild birds and beasts of various kinds, from quail and snipe to tigers and rhinoceroses. Yet it contains so many good observations on the haunts and habits of wild animals, and the author shows himself so capable a field naturalist, that a reader who looks for zoological information will probably be disappointed at not finding more novelty. The scene of Mr. Simson's principal adventures, Eastern Bengal, a vast plain traversed by mighty rivers, a country of rice fields and cane brakes, and great grass jungles, of "bheels," or marshes, and "churs," or temporary islands and sand-banks in rivers, has by no means been rendered too familiar by description. Fertile and peaceable, with never-failing rains and magnificent water communication, it furnishes few sensational paragraphs for newspaper correspondents or other manufacturers of periodical literature. The region is as little known to Anglo-Indians in general as the Highlands of Central India, so vividly described by Forsyth, or the wild Mysore country, of which the elephants, tigers, and other wild beasts found an historian in Sanderson. Why is it that the additions to our zoological knowledge made by Mr. Simson are so much less important than those made by Sanderson and Forsyth?

The explanation is probably twofold, if not threefold. All the three writers named were enthusiastic sportsmen and good observers, but Forsyth and Sanderson related events of more recent date, the details of which were naturally more vivid, whilst the present work is a series of reminiscences, written out long after the incidents described took place. The avocations of the different writers, too, were very dissimilar. Those of the two authors first named led them to pass weeks and months amongst the haunts of wild animals, whilst Mr. Simson, a Bengal civilian, could only spend an occasional holiday at a distance from his office, or avail himself of a few hours at a time during the cold season's tour. Another reason, perhaps of even more importance, is the great difference in the nature of the country, and the different system of hunting rendered necessary. The great grasses of the Gangetic plain, even when reduced to patches by the fires of the spring, conceal the movements of their inhabitants, from rhinoceroses and buffaloes downwards, far more than do the jungles of Central and Southern India, especially after their much less luxuriant grasses have been burnt. The process of beating out a patch of thick grass 10 to 20 feet high with a line of elephants differs widely in the opportunities afforded for observation, from the tracking, chiefly on foot, of the animal sought after, through the burnt glades of the Satpura hills or the comparatively thin undergrowth of the Sahyadri forests.

It must not be supposed that Mr. Simson's work contains no novel observations. A very large proportion of our acquaintance with the habits of animals, especially of the larger Mammalia, is due to sportsmen, but the value of their observations varies. A few sportsmen are deliberately untruthful,—these are easily detected; but many more are unqualified for accurate observation. There is no better test of a writer's truthfulness and capacity than his snake stories. In America it is commonly said that there is no subject on which ordinary mortals are so prone to what may euphemistically be termed "romancing." Indian experience corresponds to American, and whatever may be the deficiencies of the Bengali peasant, no one ever credited him with want of imaginative power. The Europeans in India, as a rule, know nothing about snakes. In the work under review, two of the best letters (the whole is written in epistolary form) deal with snakes, and the account of the poisonous species, all of which are correctly named and described, is excellent. To have picked out the grains of truth, and disregarded the chaff, shows judicial acumen worthy of one who has, in the administration of the law, had much experience of conflicting evidence. One of the most interesting facts mentioned is the use made of cobra venom in poisoning arrows used for the destruction of wild animals.

Another interesting observation may be noted: the shooting of a tiger "whose paunch was crammed full of grasshoppers or locusts." Hitherto, although tigers were not thought to be very particular, they were supposed to draw a line at frogs, and were not suspected of condescending to devour insects.

The plates are good on the whole, the elephants excellent, and the lithograph entitled "A scrimmage with a tiger," is one of the best representations of the animals and men depicted to be found in any Indian sporting work. But the pigs—with one exception, in which the animal looks as if he had been shaved—are far too shaggy, and resemble the European boar, *Sus scrofa* rather than the Indian *S. cristatus.* W. T. B.

THE MEASURE OF THE METRE

La Mesure du Mètre. By W. de Fonvielle. (Paris: Hachette, 1886.)

M. DE FONVIELLE'S little volume is truly national. From one end to the other it rings with applause for those brave men of France who, in 1792 and the following years, under extraordinary difficulties—political, social, and geographical—determined the measure of the arc of the meridian from Dunkirk to Barcelona; from the 1/10,000,000th part of which arc the measure of the metre was then derived.

The author in stirring language recounts the dangers and disappointments of the scientific men engaged in this work during the Revolution—Méchain, Delambre, Berthemie, Biot, Arago, Lenoir, and Lavoisier. He endeavours to awaken a warm and genuine admiration for their labours, and to show that the love of science is in some way natural to France. In pathetic words he recounts the dangers in the field: Méchain's work in Spain, his troubles at home, his recall, and return to Spain; his fears that the great measurement might never be accomplished; and at last the sad end—Méchain's death in 1807 at Plana, a victim to yellow fever. Then follows the appointment of Biot and Arago, and the account of their doubts and difficulties in completing the measurements, of the capture and imprisonment of Arago and Berthemie, of their detention in Algiers, and of their ultimate ransom and release.

M. de Fonvielle traces the development of the new system of weights and measures from the proposal of Buffon in 1790 to take as a unit the length of the seconds pendulum, to the report of the completion of the measurement of the metre in 1809. He refers to the invitation given by France in 1790 to our country, to join in an international effort to adopt one weight and one measure for all nations. This invitation, as experience has shown, ought not to have been declined, but even now, owing to the reluctance of English-speaking nations to abandon their traditional units, a similar proposal might possibly not be warmly received.

M. de Fonvielle reminds his readers that the French metric system must not be altogether regarded as a French innovation, for the Chinese long ago adopted a decimal system. It is to Shun, the sage, when Regent of the Chinese Empire, B.C. 2287, that China owes its decimal system, based on a so-called natural constant, the length of the musical standard lü, or bamboo pitch-pipe.

Of course this little volume is intended for popular reading, particularly in France. For the true account of the circumstances and results of the measurement of the arc of the meridian which passes through Paris, we must go to the "Mémoires" published by Méchain and Delambre in 1806, and to the observations of Biot and Arago issued in 1821.

OUR BOOK SHELF

Histoire Générale des Races Humaines. Introduction à l'Étude des Races Humaines—Questions Générales. Par A. de Quatrefages, Membre de l'Institut. (Paris: A. Hennuyer, 1887.)

PROF. DE QUATREFAGES and M. E. T. Hamy propose to edit a general history of the human race, and the present volume, by Prof. de Quatrefages, is intended for an introduction to a series of monographs by various authors. The dark races will be described by M. E. T. Hamy; the yellow races by M. J. Montana; and the red races by M. Lucien Biart. These volumes are in course of publication, and the first volume of the series, on the Aztecs, by M. L. Bert, has already appeared. There will be a volume on the Mongols, by M. J. Deniker, and one on the Foulahs, by Dr. Tautain.

In the present volume the general questions of ethnology are treated of, and the subject of the classification of the human race is passed in review. With that charming style which characterises the writings of this author, and which has for long made him one of the most popular writers on scientific subjects in France, he here gives a *précis* of the chief works treating on ethnology, and decides that the human race must not be placed in the same category with the animal race, because it exhibits the presence of two additional phenomena, those of morality and religion.

On the question of the unity of the human species, too often one of mere words, the *pros* and *cons* are placed before the reader in a tabular form. In the chapter on the first appearance of man, the various transformistic theories are passed in review, and the views of Darwin, Huxley, Vogt, and Haeckel are alluded to; but the author for himself believes that any certain knowledge on this point is beyond our actual powers. In other chapters, the antiquity and geographical origin of the race are treated of, as well as the subject of the peopling of the globe and the acclimatisation of the species. Primitive man is regarded as of distinct ethnic types, and from these the races took their rise. Lastly, the physical, the intellectual, and the moral and religious characters of the races are discussed in some detail. The work is supplied with numerous and excellent illustrations; it is printed in clear type on royal octavo paper, and forms a handsome volume of nearly 300 pages.

Grundzüge einer Theorie der kosmischen Atmosphären mit Berücksichtigung der irdischen Atmosphäre. Von Wilhelm Schlemüller. (Prague.)

IN this pamphlet the author introduces a modification into the ordinarily accepted dynamical theory of gases by assuming that the molecules of a gas at uniform temperature are all affected with absolutely the same linear velocity as regards magnitude, instead of the temperature being dependent on the mean or average velocity. This of course greatly simplifies the labour of deducing the fundamental relations between pressure, density, temperature, and the potential of external forces; and he claims to be able to deduce the relation, which for the terrestrial atmosphere gives Bessel's refractions to 90° (*sic*) zenith distance; agreeing with the formulæ found by Bauernfeind in 1862-64. We may remark that the convertible equations are reproduced in some cases with almost wearisome frequency, and that Joule is twice called Jonle.

Manual of Physical Geography of Australia. By H. Beresford de la Poer Wall, M.A. (Melbourne: Robertson.)

THIS little manual is written for Australian schools, and may be accepted as a fair and trustworthy account of the physical geography of Australia. For an exhaustive treatment of the subject the material is still wanting for a large section of the continent; on others, again, there is abundance of material, and of these Mr. Wall has made creditable use. It is a pity the book should be burdened with such terrible lists of names as those on pp. 9 and 10: the author would have done much better had he shown the relations of the leading capes to the general relief of the land.

An Intermediate Physical and Descriptive Geography, abridged from the Physical, Historical, and Descriptive Geography of the late Keith Johnston. (London: Stanford, 1886.)

THE late Keith Johnston's larger geography is on the whole the best general text-book of the subject in English. The present abridgment for middle-classes in schools seems to us judiciously done.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Mr. Wallace on Physiological Selection

SEEING that Mr. Wallace has now changed front with regard to some of the points at issue between us, I must once again address you upon this subject.

(1) He appears to have forgotten that the whole plan of his original impeachment consisted in representing me as an arrogant heretic. This impeachment was published under the heading "Romanes *versus* Darwin," and point by point it laboured to show that I was deserving of excommunication as a rebel against the highest authority. In my reply, therefore, I was obliged to show that the charge was misdirected; and this I did by simply quoting passages from that highest authority himself. It is needless to say that I am now as much satisfied as surprised to find this charge, not only abandoned, but reversed. Whereas I was previously accused of presumption for disregarding authority, now the remonstrance is—"he appeals to authority against me," and "I decline to accept authority as an infallible guide." So do I. But I quoted my authority merely for the avowed purpose of defending myself from the specific charge of my opponent. It was *he* who appealed to Cæsar, and cannot therefore now complain if to Cæsar he had to go. Truly, if I may employ his own mode of expression, "further discussion of the matter with such an adversary is out of the question."

(2) But, as regards one of the points, he says that my quotations appear to him to support his own views rather than mine. The shortest way of testing the value of this judgment will be to print in succession three passages, which I have selected as serving in each case most concisely and most fairly to embody the opinion of its writer. The point in question is as to whether specific characters are "invariably" adaptive, or "frequently" not so, and the italics are mine.

"When, *from the nature of the organism and of the conditions*, modifications have been induced which are *unimportant* for the welfare of the species, they *may be*, and *apparently often have been*, transmitted in nearly the same state to numerous, otherwise modified, descendants." (Darwin, "Origin of Species," p. 175.)[1]

"I believe, therefore, that the *alleged* inutility of [many] specific characters claimed by Mr. Romanes as one of the foundations of his new theory, *has no other foundation* than our extreme ignorance." (Wallace, *Fortnightly Review.*)

"The matured judgment of Mr. Darwin clearly recognised the distinction between the origin of *species* and the origin of *adaptations*,—a distinction, indeed, which necessarily follows from his repudiation of the doctrine of utility as universal. . . . . Therefore, with him I believe that an incalculable number of specific characters are of an adaptive kind, and that many more which now appear to us (in our ignorance) to be useless, will hereafter be proved to be useful. But with him also I believe that *a large proportional number* of such characters actually are destitute of utility, having been due, as he says, to 'fluctuating variations, which sooner or later became constant through the nature of the organism and of surrounding conditions, as well as through the intercrossing of distinct individuals; *but not through natural selection.*'" (Myself, *Nineteenth Century.*)

(3) "The impossibility of proving a negative is proverbial, but my opponent declares that his negative—the uselessness of specific characters—wants no proving, but must be accepted till in every case the affirmative is proved." Now, I have made no such declaration. My statement was: "It is too large a demand to make upon our faith in natural selection to appeal to the argument from ignorance, when the facts require that this appeal should be made over so large a proportional number of instances." It is really Mr. Wallace who declares that his *affirmative*—the *invariable* usefulness of specific characters—wants no proving, but must be accepted till in every case the negative is proved, notwithstanding that, as he allows, "the impossibility of proving a negative is proverbial." Of course, *if it has been previously assumed* that natural selection is the *only* factor of organic evolution, we are entitled to conclude that the doctrine of utility as universal requires no further proof, since it follows deductively from the assumption. But where the very question in dispute is as to the validity of this assumption, it becomes an almost comical instance of circular reasoning to construct our biological catechism thus:—Why do you believe that natural selection is the only factor of organic evolution? Because I know that in organic Nature utility is universal. But how do you know this, seeing that "our extreme ignorance" renders it impossible to suggest, in a vast number of cases, what the utility can be? Because I have already proved that natural selection has been the only factor at work.

(4) Mr. Wallace imports from the monthly periodicals part of our discussion on the swamping effects of intercrossing. Here therefore, I must follow him. In my Linnean Society paper I had urged that natural selection must be seriously handicapped in its action by the swamping effects of fortuitous variations intercrossing with their parent forms. This statement Mr. Wallace contradicted on the ground that Mr. J. A. Allen had furnished "a complete demonstration of individual and simultaneous variability by a series of minute comparisons and measurements," with the result of showing that, whatever modification might be required, "we *always* (italics his) find a considerable number, say from 10 to 20 per cent. of the whole, varying simultaneously, and to a considerable amount, on either side of the mean value." Now, in my reply I pointed out that all the variations thus recorded by Mr. Allen were of a kind which had "nothing to do with the difficulty," seeing that they had reference only to such features as "size, strength, fleetness, colour, relative proportions of different parts, and so on, all of which—as we well know without going beyond the limits of our own species—are so highly variable as never all to be precisely the same in any two individuals." Then, by way of illustration, I said: suppose "it were required to produce a breed of race-horses with horns upon the frontal bone, . . . or a fighting spur on a duck, clearly it could not be done by natural selection alone" in the latter case, or by artificial selection in the former; the principle of selection would here require to be assisted by "some common cause [of variation] acting on a number of individuals simultaneously." But there was nothing in the use of this illustration to provoke the remark that it indicates "the belief, apparently, that these are a class of characters which are distinctive of closely allied species"—although such does happen to be the case as regards certain allied genera. I merely requested Mr. Wallace to show me his "considerable number of specimens diverging from the mean condition," as regards either of these structures, *however incipient*—or as regards any other structures, save those the general variability of which as to relative size, &c., no one would dream of disputing. And this I still hold he is obviously bound to do, if he is to sustain his sweeping statement that whatever modification of type may be required, we *always* find from 10 to 20 per cent. varying in the needful way. Thus, as a mere matter of dialectic, I confess it appears to me a somewhat unaccountable expedient to affirm that my *reductio ad absurdum* is "preposterous"—such happening to be the very quality which this mode of refutation is ordinarily designed to present.

(5) Lastly, my critic says:—"The argument to show that the supposed physiological variations would be perpetuated, seems to me as weak and unsatisfactory as ever." This may well be. Indeed, I never supposed that anything would be likely to influence the judgment of Mr. Wallace where natural selection is concerned. But I did not write with any such object. I wrote merely to dispose of a particular criticism which he had advanced, and there can be no two opinions as to the result. For I have shown that whatever may be thought about the truth or falsehood of my theory,[1] at least it is certain that it *cannot* be affected by the criticism of Mr. Wallace; and this for the simple reason that he has run a tilt, not against my theory at all, but against a completely different theory, which, like a figure of straw, he had himself set up. Now that he can no longer have any doubt as to what my theory is, I willingly conclude that he must still have some reasons for thinking it improbable that the supposed physiological variations (if they occur) should be perpetuated. But I am free to confess that it passes my powers of conception to divine what these

[1] By a curious and undesigned coincidence, the same issue of NATURE which contains Mr. Wallace's letter also contains my review of Mr. Spencer's essay on the "Factors of Organic Evolution." In that review several other passages are quoted from Mr. Darwin's works to the same effect.

[1] I call it my theory, because I now understand that it differs widely from that of Mr. Catchpool (see NATURE, vol. xxxiv. p. 617).

reasons can be: I only know that they must be of a totally different order from those which constituted the substance of his published criticism.

Of course the question whether or not these physiological varieties *do* occur is quite distinct; and I most heartily agree with Mr. Wallace that this is a question of fact which ought to be decided, before it can be worth anybody's while to attack my suggestion upon any other grounds. If Mr. Wallace had seen this in the first instance, he might have saved both himself and me a good deal of trouble; but at the same time he would have deprived me of no small amount of encouragement. For I am now more than ever satisfied that the suggestion does not admit of being assailed on any grounds of general reasoning; but, on the contrary, that as a theory it is antecedently probable, and can only be refuted—if it is to be refuted—by an appeal to fact in the form of experiment. And as I cordially hope that this may be the last time that I shall have to address you upon this subject, I should like to neutralise the discouraging influence on experimental verification which may have been exercised by premature criticism in your pages. This I hope in some measure to effect by making two remarks. The first is that my own estimate of the antecedent probability of the theory is shared by some of the highest "authorities" on the Continent. The second is that, in all the lines of inquiry hitherto pursued, I find striking evidence of the actual occurrence of the physiological varieties in question. But as this evidence requires to be largely supplemented by experiment, and as every experiment requires at least three years to perform, those biologists who think with Mr. Wallace may be glad to hear that it will be a very long time before I shall have occasion again to trouble them with the theory of physiological selection.

GEORGE J. ROMANES

The Alleged Ancient Red Colour of Sirius

WITH reference to your paragraph last week (p. 378), in the "Astronomical Column," on "The Alleged Ancient Red Colour of Sirius," it does not seem to have been noticed that the early observations of Sirius were made at its heliacal rising. Under these circumstances the sun is a red star.

F.R.S.

A Green Light at Sunset

AT sunset to-night I observed a phenomenon which has, I believe, been seen from on board ship, but never probably from a place with such a distant sea-horizon as we have here—some seventy miles. The sky for a short distance above the point where the sun set was perfectly clear of cloud or haze, and I watched carefully the last portion of its disk disappear into the sea. As soon as the last speck of the yellow vanished, a momentary bright green flash shone out. This was quite different from the complementary green seen after looking at the setting sun; brighter and bluer in tint. I have seen it stated that the cause of this green light is the sun shining *through* the water that hides it, and would be glad to know if such is the true explanation.

R. T. OMOND

Ben Nevis Observatory, February 12

Sunset Phenomenon

ON February 21, at 5.25 local time, my attention was attracted by a bright red glow reflected from the earth outside a window having an eastern aspect.

On going out of doors to the Observatory, it was evident that this crimson light proceeded from a band of cloud about 10° in width forming a great circle in the heavens, and intersecting the horizon at points, as well as I could estimate, 145° W. and 35° E. of true north, the inclination of this great circle to the horizon being about 15° or 20°.

In less than three minutes, before I could reach the Observatory, the magnificent spectacle had completely vanished, and in the place that it had occupied were merely some streaks of cirrus and cirro-stratus, the latter being nearest to the place where the sun had set, and in half an hour the entire heavens were cloudless.

Will reflection, or refraction, or both, suffice to explain the above?

WENTWORTH ERCK

Shankhill, Co. Dublin

Aspects of Clouds

IN Mr. Ruskin's "Modern Painters" (i. Part 2) I have noticed the following passage amongst the author's remarks on the aspects of clouds:—

"I have often seen the white, thin, morning cloud edged with the seven colours of the prism. I am not aware of the cause of this phenomenon; for it takes place not when we stand with our backs to the sun, but in clouds near the sun itself; irregularly and over indefinite spaces, sometimes taking place in the body of the cloud. The colours are distinct and vivid, but have a kind of metallic lustre upon them."

And again, the author describes the "scattered mists rallying in the ravines and floating up towards you along the winding valleys till they couch in quiet masses, *iridescent* with the morning light, upon the broad breasts of the higher hills."

Dr. Johnstone Stoney recently read a paper to the Royal Dublin Society entitled "The Iridescent Phenomena in Clouds," wherein he explains the cause of a somewhat similar appearance which clouds at times present. Their outer portions are suffused with soft shades of colour like those of mother-of-pearl, a lovely green being generally conspicuous. The tints are usually distributed in irregular patches as in mother-of-pearl, but in some cases they form a regular fringe. Dr. Stoney explained that these phenomena are due to particles of ice, in the form of crystals of various sizes and shapes, and according to their position and character the sun's rays are reflected through them in various colours, thus producing the beautiful effect.

Would this be an explanation of the appearances to which Mr. Ruskin refers?

ROBERT JAMES REILLY

Boyle, Ireland, February 17

A Recently-Discovered Deposit of Celestine

IT may, perhaps, be worth mentioning that a large and valuable layer of celestine has been lately found at Yate, in Gloucestershire. It lies just below the sub-soil upon a bed of red Triassic marl, which rests unconformably upon the coal-measures, just at the eastern edge of the Bristol coal-field in that district.

The deposit is, for the most part, about half a metre or more in thickness, and consists chiefly of loose nodules which, when broken, are seen to be masses of white, crystalline, nearly pure celestine. Geodes are occasionally found, one of which, about 15 cm. in diameter, lined with fine clear crystals, is now in our school museum. Beautifully transparent, though not well crystallised masses of selenite also occur in the deposit, and in these are sometimes inclosed single detached crystals of celestine. I picked out one crystal (though it seemed almost sacrilege to break up the fine specimen of selenite), which is about 7 × 4·5 × 1·5 cm., doubly terminated, fairly clear, and showing very perfect, well-developed faces. Its density is 3·95, and it shows very perfectly the characteristic light-bluish tinge of celestine.

It would, I think, be quite worth while for any mineralogist who happens to pass near Bristol to pay a visit to the place, which is only about twelve miles distant on the Midland Railway to Gloucester. The extent of the deposit is not known, but when I was there in October last, and again at Christmas, it was being worked in several fields north-east of the church, about a mile and a half from the station. Large quantities are being sent away, of course for the purposes of sugar-refining and adulterating white-lead paint.

H. G. MADAN

Eton College, February 21

"Culminating Sauropsida"

IT is with satisfaction that I note in NATURE of February 3 (p. 331), that Prof. W. K. Parker finds it more and more impossible "to conceive of birds as arising *direct* from the Dinosaurians, or indeed from any other order or group of reptiles." The sentence, no doubt, suggests an indirect origin of birds from reptiles; but, further on, Prof. Parker explains that if protovertebrate forms existed it is quite supposable that a metamorphosis may "have taken place of this and that *quasi*-larval form into archaic reptile, ancestral bird, or primitive mammal." We must therefore conclude, either that there were two kinds of protovertebrates, namely, piscine and reptilian—or ichthyopsidan and sauropsidan, as Prof. Parker would probably prefer to call them—fundamentally distinct or preceded by common ancestors, and in neither case themselves entitled to be called protovertebrates, or else that the protovertebrates referred to were ichthyopsida, that is to say, more simply, allied to the amphibia. I do not object to that latter supposition. I suggested it myself in 1884 (*Journal of Anatomy and Physiology*, xviii. p. 356), as perhaps Prof. Parker is aware. But if birds are developed from amphibians or pre-amphibians, and if Prof. Huxley is right, as I believe he is, in supposing that the connection of mammals with amphibians is neither through reptiles nor birds, we come to this: that amphibians or pre-amphibians have furnished the common stem whence reptiles, birds, and mammals have diverged. In that case there is an end of that group, "Sauropsida," which the birds are alleged by Prof. Parker to "culminate."

But, further, amphibians are certainly more closely allied to reptiles than to either birds or mammals. Cuvier's system may therefore be justly reverted to, and the Amphibia or Batrachia be considered as the lowest division of the Reptilia, which I do not for one moment doubt is the true classification.

University, Glasgow, February 8 JOHN CLELAND

The West Indian Seal (*Monachus tropicalis*)

IT will probably be of interest to the zoological portion of your readers to learn of the re-discovery—or the full discovery—of the West Indian seal (*Monachus tropicalis*). The history of this pinniped is in brief as follows.

It was first noticed by Columbus in his account of his second voyage (1494) as having been found in some numbers on the rocky isle of Alta Vela, off the southern shore of Hispaniola, where his sailors killed eight of them for food. Later—in 1675—Dampier found this seal in abundance on the Alacram reefs, about 80 miles north of Yucatan. At that time it was killed there in great numbers for its oil.

The seal then remained unnoticed for over a century and a half, having no place whatever in the writings of zoologists until 1843. Then Mr. Richard Hill published an account of it in the "Jamaica Almanac," calling it the Pedro seal, from the Pedro Keys, some 60 miles south of Kingston, Jamaica, where he had found it. A few years later Mr. P. H. Gosse obtained an imperfect skin (without skull) which he sent to the British Museum, where it was described by Dr. Gray in the Proceedings of the Zoological Society of London, 1849. Dr. Gray gave it then no name, probably by reason of its imperfect characters. Later—in 1850—(Catalogue of Mammals in the British Museum) he described this same specimen as *Phoca tropicalis*, and afterwards (Catalogue of Seals and Whales, 1866) as *Monachus tropicalis*. But so imperfect was the specimen on which the description was founded, and the animal itself was so little known, that even its generic relations were in doubt, and its reference to the genus Monachus was considered provisional. From thence on to the present, rumours of the existence of this seal have been not unfrequent, but nothing seemed trustworthy and positive, and no specimens were obtained, if we except a young skin, without bones or skull, which came from Cuba to the National Museum at Washington, in 1884, without any indication as to locality.

It has long seemed to the writer—as, doubtless, to many others—that the certain presence in our waters of so important a mammal lying *perdu* in regions which our naturalist collectors are yearly visiting, was the opprobrium of American zoologists. We made inquiries, and collected notes from many sources, which showed clearly that this seal existed at isolated points—on small islands and keys—not only in the Caribbean and among the Bahamas, but also in the Gulf of Mexico. Last summer, while on a visit to the western shore of the Gulf of Mexico, we were so fortunate as to *locate* this seal with much certainty. This was upon the Triangles (Los Triangulos), three little keys, hardly above the water-level at high tide, and lying some 100 miles north-west off the Campeachy coast, in latitude N. 20° 50′, and longitude W. 92° 10′. Following this clue, my son, Mr. Henry L. Ward, last December visited the Triangles in company and partnership with Señor F. Ferrari Perez, naturalist of the Mexican Geographical and Exploring Expedition. His hunt was highly successful, and he has during the present month returned with nearly twenty specimens—skeletons and skins of all ages, from a suckling to the fully adult male, 7 feet in length. This ample material has just been carefully studied by Prof. J. A. Allen, the well-known zoologist, and author of the "Monograph of North American Pinnipeds." Prof. Allen has given a preliminary notice of the specimens in *Science*, January 14, 1887, and promises an elaborate account, with plates, in an early issue of the Bulletin of the American Museum of Natural History, New York.

It is a fact of rather peculiar interest that this, the first large mammal ever discovered in America, should, by the strange mishaps of natural history collecting, be the very last one to become known satisfactorily to science. HENRY A. WARD

Rochester, N.Y., January 30

An Abnormal *Hirudo medicinalis*

WHILST dissecting the leech in the class of practical zoology, one of my students directed my attention to an apparent abnormality in the specimen which it fell to his lot to dissect. On careful examination it was found that the vesicula seminalis of the right side had moved forwards into the fifth somite, and there opened into the base of a second and fully-developed penis, which opened to the exterior on the second annulus of the fifth somite. From the vas deferens, however, there passed off to the normal penis a duct which had on it a swelling corresponding in position to the vesicula seminalis, which had been moved forwards. The various parts on the left side, as well as the female organs, were quite normal.

R. J. HARVEY GIBSON

Biological Laboratory, University College, Liverpool, February 14

Instinctive Action

SOME years ago I was about to drown a terrier pup of about a month old. I held it across the palm of my open hand over a large tub of water. It lay quite still on my hand as I gently lowered it. When within 4 inches of the surface, but not yet touching the water, it deliberately began, and continued as long as I held it there, the paddling motion with its feet peculiar to dogs when swimming, and quite unlike that of walking, although I am perfectly certain this puppy had never seen or touched water before. We know almost all animals swim when first placed in water, but how could this puppy know before it touched the water that this peculiar action would be necessary? Has a similar case been observed by any of your readers?

Birmingham, February 17 D. W. C.

THE RELATIONS BETWEEN GEOLOGY AND THE MINERALOGICAL SCIENCES[1]

I.

THE realm of Nature has been recognised from time immemorial as consisting of three kingdoms: dealing with the affairs of these three kingdoms, respectively, there have grown up side by side three departments of natural knowledge—zoology, botany, and mineralogy. But in recent years new and, I cannot help thinking, regrettable relations have sprung up between these sister sciences. Zoology and botany, having developed a method, a classification, and a nomenclature, based on common principles, have been drawn together by bonds so close and firm that many regard them as indissolubly one—the science of biology. Mineralogy, thus isolated, has been driven to seek new and unnatural alliances—with chemistry, with physics, or with the mathematical sciences. For my own part I confess that I regard this threatened "Repeal of the Union" of the natural sciences as alike a misfortune and a mistake.

It is sometimes assumed that the objects dealt with by zoology and botany are so different in their essential characters from those treated of by mineralogy, that the science of "organic" Nature must always follow a different path from that pursued by the science of "inorganic" Nature. The structures commonly known as *organic*, and the processes usually called *vital*, are asserted to be so entirely different, alike in their origin and in their essence,

[1] Address to the Geological Society at the Anniversary Meeting on February 18, by the President, Prof. John W. Judd, F.R.S.

from anything existing in the mineral kingdom, as to warrant the establishment and perpetuation of a fundamental distinction between the sciences dealing with "living" and "non-living" matter respectively.

In the year 1854 a very acute thinker, who at one time occupied this chair, made a serious attempt to formulate the distinctions which are supposed to divide living from non-living matter; but at a subsequent date, admitting with characteristic candour that he had altogether outgrown these ideas, Prof. Huxley argued, with great skill and cogency, that "vitality" is merely a general term for a set of purely physical processes, differing only in their complexity from those to which "inorganic" matter is subject.

It is a circumstance of no small significance that no definition of *life* which has yet been proposed will exclude the kind of processes which we can now show to be continually going on in mineral bodies. "Life," said the late George Henry Lewes, "is a series of definite and successive changes, both of structure and composition, which take place in an individual without changing its identity." Mr. Herbert Spencer prefers to define life as "the definite combination of heterogeneous changes, both simultaneous and successive, in correspondence with external co-existences and sequences."

If either or both of these definitions of life be accepted as satisfactory, then, as I hope to demonstrate to you, the minerals which build up the crust of our globe unquestionably live. At all events I am confident of being able to show that "in correspondence with external co-existences and sequences," or, in other words, as the conditions to which they are subjected vary, they undergo "a series of definite and successive changes, both in structure and composition, without losing their identity."

It may seem paradoxical, but it is nevertheless true, that the "vitality" of minerals—I really do not know what other term to use to convey my meaning—is much greater than that of plants, and, *a fortiori*, than that of animals; and this is the direct and necessary consequence of their less complex and more stable chemical constitution.

The zoologist regards as a case of remarkable vitality the recovery of snails which had been long affixed to a museum-tablet, upon their immersion in warm water. The botanist cites the germination of seeds taken from ancient Egyptian tombs as a striking illustration of how long life may remain dormant in the vegetable world. Let us now turn to the mineral kingdom. A quartz-crystal develops to certain dimensions, in accordance with the natural laws of its being, and when the necessary conditions of growth cease to environ it, its increase is arrested. But the crystal still retains its "vitality," that is, the power of further development which is dependent on its particular "organisation" or molecular structure. We may destroy that "organisation" and the "vitality" which is dependent upon it in a single instant, by subjecting the crystal to the action of hydrofluoric acid or of an oxyhydrogen flame. But unless its "organisation" and "vitality" be thus brutally stamped out, the crystal and, indeed, every fragment of it retains, not the "promise" only, but the very "potency of life." It may be worn by wind and wave into a rounded and polished sand-grain; it may be washed from the beds of one formation, to form part of the materials of a new one, and this process may be repeated again and again; but after countless wanderings and unnumbered "accidents by flood and field," extending over millions on millions of years, let but the necessary conditions of growth again environ it, and the battered and worn fragment will re-develop, in all their exquisite symmetry, its polished facets, it will assume once more the form of a quartz-crystal, having at least as much claim to *identity* with the original one, as a man has with the baby from which he has grown.

"Life!" "Vitality!" These terms are but convenient cloaks of our ignorance of the somewhat complicated series of purely physical processes going on within plants and animals. "Organisation!" Why should the term be applied to the molecular structure of an *Amœba* or a yeast-cell, and refused to that of a crystal? But even if we choose to insist on such distinctions as these, must we also make them a basis on which to establish our classification of the sciences?

Unquestionably there are differences between the cycles of change which take place in animals, plants, and minerals respectively. As the animal differs from the plant in not being able to build up its tissues from the simple compounds of the mineral kingdom, so both animals and plants differ from minerals in their power of growth by intussusception.

But perhaps the most striking difference of all between the "vital" processes in animals, plants, and minerals, is found in the *rate* at which they take place. Animals, in consequence of the instability of their chemical constitution, are distinguished by an almost ceaseless activity and a consequent brevity of existence. Plants, in the slower rate at which their vital processes take place, bridge over to some extent the tremendous gap between animals and minerals. In these last the vital processes are so prolonged in their manifestations, owing to the stability of their chemical composition, and they are not unfrequently interrupted by such enormous intervals of time, that they are only recognised by the geologist.

The cycles of change which take place in an ephemera are rapid indeed as compared with those going on in the oak-tree, among the branches of which it lives; but in the rocks among which the oak thrusts its rootlets, other processes are going on compared with which the life of the oak-tree is as "fast" as that of the ephemera compared with its own.

Nevertheless the three forms of life seem to start pretty much on a level. A solution of nitre in which crystallites are uniting, in obedience to the laws of polarity, to build up crystals, with their regular forms, their molecular structure, and their powers of further development; a solution of sugar, in which the cell of a yeast-plant is living and growing; and a third liquid with floating vegetable particles, in which an *Amœba* is increasing and multiplying;—these three may surely be compared with one another, however unlike may appear to be the higher developments in the three kingdoms to which they respectively belong.

I do not, of course, for one moment wish to suggest that it is practicable, or even desirable, to attempt an extension of the conventional use of the terms "life" and "organisation." But I do think that it is of the first importance that we should clearly recognise the fact that the distinctions between living and non-living matter are not essential and fundamental ones, that cycles of change exactly similar in almost every respect to those occurring in the animal and vegetable kingdoms are equally characteristic of the mineral kingdom; though, in the latter, they are more difficult to follow on account of the extreme slowness with which they take place.

When this great truth is fully recognised, the separation of the biological and the mineralogical sciences will be at an end, and mineralogy will begin to profit by that revolution in thought and in method which has already done so much for her sister sciences.

The temporary divorce between biology and mineralogy has arisen, not from any inherent differences between their aims, their methods, or the objects of which they treat, but from the circumstance that, while the former has in the last half century advanced with the stride of a giant, the latter has during the same period tottered on with the feeble steps of infancy. Mineralogy is still in the "pupa-stage" of its development; it is a classificatory science, with its methods imperfect, its taxonomy undeveloped, and its very notation undefined. Its cultivators, absorbed in the Sisyphean task of establishing new species and varieties, too often treat their science, with all its glorious possibilities, as though it were but akin to postage-stamp lore!

How is it, we may profitably ask, that the biological sciences have made such prodigious advances, while the mineralogical ones have lagged so far behind? We must ascribe the result, I believe, to two causes:—

In the first place, improvements in the construction of the microscope, and more especially the perfecting of methods of study by means of thin sections, have immeasurably enlarged the biologist's field of observation; histology and the cell-theory, embryology with all its suggestiveness, and many important branches of physiological research, must have languished, if, indeed, they could ever have seen the light, but for aid afforded by the microscopical methods of inquiry.

In the second place, the growth of geological and palæontological knowledge has been the leading factor in that profound revolution in biological ideas which, sweeping before it the superstition of fixity of species, has endowed this branch of natural science with the transforming conception of evolution.

Now these two causes, which have done so much for biology, are already working out the regeneration of mineralogy; and I doubt not that the fruits brought forth by the latter science will be equally satisfactory with those of the former.

The application of the microscope to the study of minerals has proved less easy than in the case of animal and vegetable structures. More than a century ago, it is true, several French geologists employed the method of crushing a rock, and of picking out from its powder the several minerals of which it was composed, for microscopic study; and in 1816, Cordier endeavoured, by systematising the methods followed by his predecessors, Daubenton, Dolomieu, Fleurian, and others, to elaborate a scheme for the mineralogical analysis of rocks by the aid of the microscope. In recent years the French geologists, with MM. Fouqué and Michel Lévy at their head, have shown how, by the employment of the electro-magnet, of fluids of high density, and of various chemical reagents, this work of isolating the several minerals of a rock for microscopic study or chemical analysis may be greatly facilitated.

But the great drawback to this method of microscopic study of rocks, as devised in France, was found in the circumstance that it began by destroying the rock as a whole, and hopelessly obliterating the relations of its mineralogical constituents. Delesse and other observers, it is true, succeeded in obviating this difficulty, to some extent, by studying the structure of rocks as seen in polished surfaces under the microscope by reflected light.

The greatest step in advance in connection with the microscopic study of rocks was undoubtedly made, however, when it was shown that transparent sections of minerals, rocks, and fossils can be prepared, comparable to those so constantly employed by biologists in their researches. William Nicol, of Edinburgh, was the first to discover, in the year 1827, how the mechanical difficulties in the way of the preparation of such sections could best be surmounted; while Mr. Sorby, in a memorable communication to this Society, in 1858, showed us the first-fruits of the wonderful harvest of results to be obtained by the employment of this method.

But if the birthplace of the one method of microscopic study of rocks was France, and of the other Britain, it must be confessed that a large part of the merit of developing and improving these methods of inquiry is due to the Germans. To the labours of the numerous, patient, and accurate students in that country must be ascribed much of the perfection to which the methods of microscopic mineralogy have now attained; though we must not forget in this connection many most valuable contributions to the study from Scandinavia, Holland, Italy, and the United States.

As in the case of biology the results attained by the geologist have been the means of awakening new interests and inspiring a new philosophy, so in the case of mineralogy other problems have been suggested, and entirely fresh conceptions of the scope of the science have followed from the development of geological thought. We are thus led to regard minerals, not simply as a set of curious illustrations of mathematical and chemical laws, but as important factors in the evolution of the globe. Mineral collections in the past have resembled greenhouses, wherein only beautiful, though often abnormal growths are admitted; but in the future they will be like the herbaria of the botanist, where mere beauties of form and colouring are subordinated to the illustration of natural relationships and to the elucidation of the great problems of origin and development. Far be it from me to undervalue those wonderful crystals, the choice flowers of the mineral kingdom, which adorn our museums; but as there are many plants of extreme scientific interest which happen to possess only inconspicuous flowers, so there are not a few microscopic minerals, the study of which may lead us to the recognition of some of the most important laws of the mineral world.

I believe that what geology has already done for biology she is now accomplishing for mineralogy; it may, indeed, be instructive to point out how, in every one of its departments, the employment of microscopic methods and the suggestion of new lines of thought is causing mineralogy to develop in just the same directions as biology has already taken before her. In this way we may perhaps best convince ourselves that mineralogy is once more asserting her position in the family of the natural sciences.

Every natural-history science presents us with four distinct classes of problems. With respect to the objects of our study, we may make inquiries concerning their forms, their actions, their relations, and their origin. The answers to the first class of questions constitute *Morphology*, to the second *Physiology*, to the third *Chorology* or *Distribution*, and to the fourth *Ætiology*. The great problems of the mineral world, as I shall proceed to show, fall under precisely the same categories; and we may perhaps gather some useful hints by a comparison between the immature results of the mineralogist in each of these departments and those more perfect ones which have been attained by the botanist and zoologist.

The morphology of minerals was for a long time studied to the exclusion of all other branches of the science; for the problems connected with form and structure were those which naturally first attracted the students of the "inorganic" world.

Few generalisations of science are so beautiful, and at at the same time so suggestive, as those which have been arrived at by a discussion of the accurate measurements of crystal-angles. The constancy, within certain narrow limits, of corresponding angles, amid the almost infinite diversity of form assumed by crystals of the same mineral, is not less striking than the simplicity of the mathematical laws by which all these varied forms can be shown to be related to one another.

But the study of the morphology of minerals, which cannot be carried beyond a certain point by the aid of the goniometer, is capable of being pushed infinitely farther when we investigate the internal structure of their crystals, as illustrated by their optical and other physical properties. Not only do we find the minutest details of their external form to be correlated with peculiarities of molecular structure, as revealed by their action on a beam of polarised light, but delicate differences in internal organisation which the goniometer is powerless to detect, become clearly manifested under the searching tests of optical analysis. For the mineralogist, indeed, the polariscope with its accessories has supplemented the goniometer, in the same way as the spectroscope has the balance of the chemist.

What has been stated concerning the optical characters of minerals is equally true of their other physical properties; for the researches of recent years have shown all these properties to be intimately related to the symmetry of the crystal in which they are displayed. In every crystal, the faces of each group bearing the same relations to its axes exhibit characteristic peculiarities in their lustre, in their hardness, and in the manner in which they are acted upon by solvents; and these serve to distinguish such groups of faces from others in the same crystal having different relations to its axes. The elasticity of crystals, their power of conducting heat and electricity, and their phosphorescent, electric, or magnetic properties, whether natural or induced, are all manifested in varying degrees along certain directions which can be shown to be related to the particular symmetry of the crystal. And the more carefully we study both the forms and the physical properties of minerals, the more are we impressed by the conviction that the most intimate relations exist between these characters and the chemical composition of the minerals.

The phenomenon of "plesiomorphism," as Miller proposed to call it, that is, the slight variation in the angular measurements of crystals in the same species or group, when any of the constituents are replaced by vicarious or isomorphous representatives, very strikingly illustrates this conclusion. And the exact study of the optical properties of minerals shows that the slightest variation in the relative proportions of these vicarious constituents makes its influence felt by changes in their colour, in their pleochroism, in the nature and amount of their double refraction, in the position of their optic axes, and, indeed, in the whole assemblage of the properties of the crystal.

To the admirable investigations of Tschermak on the feldspars, the amphiboles and pyroxenes, the micas, and other groups of minerals, we are largely indebted for the establishment of this conclusion; while Doelter, Max Schuster, and other mineralogists, have contributed many striking observations which serve to extend and fortify it.

The application of the microscope to the study of the internal structure of minerals—their histology—has led to the recognition of many beautiful and unsuspected phenomena. Examined in this way, the seemingly homogeneous masses exhibit many interesting intergrowths and inclosures; and the study of these, as shown by Sorby, Vogelsang, Renard, and Noel Hartley, may serve to throw new and important light upon the conditions under which the crystals were originally developed. Cavities containing carbonic acid and other liquids, with bubbles in constant and, seemingly, spontaneous movement, serve to awaken the interest of the naturalist not less powerfully than the mysterious creeping of protoplasm in the hair of a nettle, or the dance of blood-corpuscles in the foot of a frog!

Others among these histological peculiarities of crystals must be regarded as having a pathological significance; they are abnormal developments resulting from unfavourable conditions to which the crystals may have been subjected during their growth, or in the course of their long and chequered existence.

The variability exhibited in crystals of the same mineral is sometimes very startling. In addition to the varieties due to the combinations of many different forms, or to the excessive development of certain phases at the expense of others, we have the complicated and diversified structures built up by twinning according to different laws. Again, by oscillatory tendencies in the same crystal towards the assumption of different forms, or by the existence of causes calculated to interfere with the free action of the crystallising forces, we may obtain varieties with curiously curved or striated faces. Not unfrequently large quantities of extraneous materials, solid, liquid, or gaseous, may be caught up in the crystal during its growth, and these foreign substances may be so far affected by the polar forces operating around them as to be made to assume definite and symmetrical positions within the crystal.

Even in the case of minerals of identical chemical composition and similar crystalline form, marked variations in physical properties may result from differences in the conditions under which they have originated. In lustre, density, and other characters, adularia differs from sanidine, and elæolite from nepheline. Dr. Arthur Becker has shown that quartz exhibits marked variations in its specific gravity, according to the particular conditions under which it has been formed.

There is one kind of morphological variability in minerals which has during recent years attracted a great amount of attention, and excited much discussion among mineralogists. Soon after his memorable discovery of the relations between the crystalline forms of minerals and their optical properties, Brewster detected certain apparent exceptions to his important generalisation; and since his day many additions to these curious anomalies in the optical behaviour of minerals have been made by other observers. So greatly, indeed, have these been multiplied in recent years, that it is doubtful whether any mineral crystallising in the cubic, the tetragonal, or the hexagonal system could be cited in which the optical properties are precisely what they ought to be according to theory; and similar anomalies are also found in crystals possessing lower degrees of symmetry.

The attempts which have been made by some crystallographers to account for these optical anomalies in crystals, by assuming that they possess only a pseudo-symmetry, the result of very complicated twinning, ingenious as they undoubtedly are, remind one of the wonderful addition of eccentrics and epicycles by which astronomers so long sought to maintain the credit of the Ptolemaic theory. But as, in the latter case, complexities and difficulties alike vanished when the centre of the system was shifted from the earth to the sun, so have the discoveries of Klein, Rosenbusch, and others removed the necessity for the painfully elaborate crystallographic hypotheses to which we have referred.

Most mineralogists will now be prepared to admit, as the result of these researches, that the perfection alike of form and of optical properties which characterises a crystal when first formed, is liable to slight modification, as the conditions of temperature and pressure under which it exists vary. In consequence of this, almost all natural crystals are found, when we study them with sufficient care, to exhibit slight but very striking and significant differences in form and optical behaviour from what they ought theoretically to possess.

While our knowledge of the ordinary mineral varieties promises to be vastly extended by the improvements which have been made in the methods of optical and chemical diagnosis under the microscope, there is, at the same time, reason to hope that the relationship of these numerous varieties will, by the same means, be made more clearly apparent. As the existence of well-defined natural groups of minerals becomes more clearly established, through the study of interesting though inconspicuous links, we shall obtain a basis for a much-needed reform in mineral taxonomy and nomenclature.

The more carefully we pursue our researches among the diversified forms of the mineral world, the more are we impressed by the conviction that each mineral, like each plant or animal, possesses its own individuality. Nature does not make *facsimiles* in the mineral, any more than in the vegetable or the animal kingdoms. All the sciences of Nature must be content to recognise individuals as the only real entities, and to accept species, like genera, families, and orders, as convenient but purely artificial conceptions.

The geological study of minerals leads us to regard each specimen that we examine as possessing a distinguishing combination of properties, some of which are impressed upon it by causes operating when it came into being, while others are no less clearly the result of the long series of vicissitudes through which it has since passed.

Of all the branches of mineral morphology there is none from the study of which the geologist has gained more in the past, or from which he has greater reason to look for future aid, than that of the embryology of crystals.

In the year 1840 Link showed that the first step in the formation of crystals in a solution consists in the separation of minute spherules of supersaturated liquid in the mass; and subsequently Harting in Holland, and Rainey and Ord in this country, obtained a number of interesting experimental results, by allowing crystallisation to take place slowly in mixtures of crystalloids and colloids.

Valuable contributions to the same subject were made by Frankenheim, Leydolt, and others; but it is to Hermann Vogelsang that we owe the greatest and most important contributions to mineral-embryology. By the ingenious device of adding viscous substances to solutions in which crystallisation was going on, he succeeded in so far retarding the rate at which the operation took place as to be able to study its several stages. He thus showed how the minute "globulites," gathering themselves into nebulous masses or ranging themselves according to mathematical laws, gradually build up skeleton-crystals, by the clothing of which the perfect structures arise.

Since the early and regretted death of Vogelsang, the subject of the development of crystals from their embryos, the so-called *crystallites*, has been successfully prosecuted by Behrens, Otto Lehmann, Wichman, and other investigators.

Now in all glasses—whether of natural or artificial origin—in which the process of primary devitrification is going on, we have examples of the growth of crystals in a viscous and retarding mass, and in these, as Leydolt, Zirkel, and Vogelsang clearly saw, admirable opportunities are afforded to us for studying the formation of crystallites, and the laws which govern the union and growth of these into crystals. Two years ago, my predecessor in this chair submitted to you the interesting results of his own researches upon the devitrification of artificial glasses and slags; and the subject has since been pursued by Velain in France, and by Hermann and Rutley in this country.

The igneous rocks supply us with admirable opportunities for studying mineral embryology. In the same rock-mass we may sometimes find every possible graduation, from an almost perfect glass to a holocrystalline aggregate. By the study with the microscope of the several transitions in different parts of the mass, we obtain data for the most important conclusions concerning the phenomena of crystal-development.

There is another line of research in connection with mineral-embryology, which appears to be full of promise, and which has not yet received all the attention it deserves. In the "contact-zones" around great igneous intrusions, we find the curious so-called "spotted slates," which under the microscope are seen to contain nebulous patches, the mere ghostly presentments of crystals, struggling into being in the amorphous mass. The development of these nebulous masses into perfect crystals, exhibiting the characteristic external forms and optical properties of andalusite and kyanite, of garnet and epidote, of hornblende and mica, may be traced in some cases with the greatest facility.

More complicated still are the phenomena exhibited along the foliation-planes of the rocks, which have been made to flow in the act of mountain-making. There, as the old minerals are destroyed, new ones build themselves up from their elements. The study of all the steps of this process is an undoubtedly difficult one, but the results already obtained by Reusch, Lossen, Heim, and Lehmann, by Lapworth, Teall, Roland Irving, and Williams, lead us to look hopefully forward to the full solution of the grand but complicated problems of regional metamorphism.

The field of mineral-embryology is indeed a promising one, and its diligent cultivators may hope to gather a harvest no less rich than that which has been reaped by the workers in the same department of the biological sciences.

(*To be continued.*)

TABASHEER

I HAVE often wondered that this curious substance has never attracted more attention. But scanty references to it are to be found in books, and yet it seems to me that few more singular things are to be met with in the vegetable kingdom.

In Watts's "Dictionary of Chemistry" (vol. v. p. 653), exactly six lines are devoted to it. It is defined to be: "Hydrated silica, occurring in stony concretions in the joints of the bamboo. It resembles hydrophane, and when thrown upon water does not sink till completely saturated therewith." It is further stated to be the least refractive of all known solids, and an analysis by Rost von Tonningen of a specimen from Java gives a composition of 86·39 per cent. silica soluble in potash, 4·81 potash, 7·63 water, with traces of ferric oxide (to which I suppose its occasional yellowish colour to be due), lime, and organic matter.

There are several specimens in the Kew Museums, partly derived from the India Museum. All consist of small irregular angular fragments, varying from the size of a pea downwards, and opaque white in colour. It is obvious that these fragments are the debris of large masses.

Now, the presence of considerable solid masses of so inert a substance as hydrated silica in the plant-body is a striking fact. At first sight, one might compare it do the masses of calcium phosphate which form the endo-skeleton in the higher animals. These, however, serve an obvious mechanical purpose, which cannot be attributed to the lumps of tabasheer in the hollow joints of a bamboo. The presence of silica may sometimes serve an adaptive purpose, as in the beautiful enamelled surface of canes. And according to Dr. Vines ("Physiology of Plants," p. 21), "Struve found that it constitutes 99 per cent. of the dry epidermis of *Calamus Rotang*."[1]

In a few other groups of plants, such as *Equisetum* and the *Diatomaceæ*, it is a characteristic constituent. In all cases it principally occurs in the cell-wall (Vines, *l.c.* p. 137. This has suggested the highly ingenious speculation that, seeing the intimate chemical relationship which obtains between silicon and carbon, there might be a silicon-cellulose. I notice that Count Castracane, in his Report on the *Diatomaceæ* collected by the *Challenger*, speaks of its "having been already shown that silica is sometimes substituted for carbon in the formation of cellulose" (p. 7). Judging from ash-analyses it might be supposed that silica was an essential constituent of gramineous plants. But by the method of water-culture Sachs has found that maize, for example, will grow with only a trace of silica. I must confess to ignorance of all that may have been done in the matter recently. But Ladenburg thought, and I think with reason, that the indifference of the plant to silica was a

[1] Sachs remarks ("Text-book," second edition, p. 700) that silica accumulates chiefly in the tissues exposed to evaporation, though this clearly does not apply to the case of diatoms.

strong argument for a silicon-cellulose in which silicon might or might not with equal physiological convenience play the part of one or more atoms of carbon. Fascinating as this hypothesis is, I am bound to say that the prolonged investigation which he devoted to the question is on the whole adverse to the idea of silicon playing any part of the kind.

It still remains then an unsolved problem why, when no adaptive end is involved, plants should take up such relatively enormous quantities of silica. The case of the frustules of *Diatomaceæ* is peculiar, as there the silicious wall is apparently a continuous plate of inorganic matter capable of resisting without impairment treatment by the most destructive and disintegrating agencies known Yet Castracane adduces evidence to show that such walls can grow; and as this can only be by interstitial growth, a molecular constitution is implied quite different from anything physical, and precisely similar to that of a cellulose membrane. He quotes, indeed, von Mohl for the opinion that the wall is not simply inorganic, "but only an organic membrane which is impregnated with silex."

Now, in the case of tabasheer, it is quite evident that the plant takes up an amount of silica beyond its powers to use, and so it is exuded into the hollow cavities of the bamboo stem. I do not mind confessing that, in so far as I had reflected on the matter at all, I had pictured to myself this as taking place by some process of secretion, so that the mass of tabasheer ultimately accumulated from successive portions of thrown-off silica. I was obliged, however, to give a little more serious thought to the matter when Prof. Cohn, of Breslau, wrote to me that he proposed to investigate the whole subject, and asked for help in the way of specimens and information. It then struck me what a very singular thing the phenomenon of the occurrence of tabasheer really was. I set to work to hunt up in the literature of Indian botany some rational account of the matter. The only ray of light I got was from the "Forest Flora of North-West and Central India," by Dr. Brandis, late Inspector-General of Forests to the Government of India. Everyone who knows Dr. Brandis knows that he gave to administration the energy he would more willingly have devoted to scientific pursuits. I was not at all surprised to find, therefore, modestly hidden in his book (p. 566) the key to the riddle. He says: It is not at all impossible that the well-known silicious deposit (*tabasheer*) which is found in the joints of this and other species [*Bambusa arundinacea*] may be the residuum of the fluid which often fills the joints." I communicated this to Prof. Cohn, and he was good enough to tell me that he quite agreed that this was the correct explanation. I at the same time wrote to Dr. King, the distinguished Superintendent of the Royal Botanic Garden, Calcutta, to know if it were possible to procure specimens of tabasheer *in situ*, as we possessed in our Museum nothing but broken fragments. I extract from several letters he has written me the following particulars:—"January 11. I have inquired of several old workers as to the situation tabasheer occupies. They all say it is found either on the *floor* of the joint, or if (as is so often the case in *B. Tulda*) the stem leans over, it is also found on the lower wall. It is never found on the roof of a joint. . . . . Tabasheer is not common in bamboo grown near Calcutta. And, besides, it is apt to be forced out of its natural position by the forced used in breaking a joint open. There is no external mark by which a tabasheer-bearing joint can be recognised prior to being opened." "January 18. I have got a specimen of tabasheer *in situ* for you. It concretes *as a jelly*, and is now being carefully dried off."

I think that these extracts (in which the italics are mine) fully confirm the explanation as far as I know first put out by Dr. Brandis. The rapidity of growth of a bamboo shoot is well known to be enormous. The root-pressure is probably equally great. The joints, at first solid, become hollow by the rending apart of the internal tissues, and water containing silica in solution is poured out into the cavities so formed. When the foliage is developed, transpiration is active: the water taken up from the ground is rapidly got rid of; not merely is the root-pressure compensated, but the water poured out into the joints is re-absorbed. It is not easy to see why the silica should not be always taken with it, as in the vast majority of cases it no doubt is. But in the cases in which it is left behind it has apparently simply undergone a process of dialysis. The determining causes of the occasional deposit of tabasheer are, I think, still obscure. But, as Prof. Cohn intends to investigate the subject, I think we may pretty confidently look forward to an exhaustive explanation.

It is a well-known fact that a large proportion of the ash-constituents of plants may have but little significance in their nutrition. The chemical constitution of plants, as far as their ash is concerned, to a large extent varies with the nature of the soil in which they are grown. It is quite certain that they will in consequence take up a vastly larger proportion of certain constituents than they can turn to any physiological account. Tabasheer is a striking instance of one such case. The calcareous masses found in the wood of many Indian trees mentioned in NATURE, vol. xxi. p. 376, affords another.

W. T. THISELTON DYER

ON THE EARLIER TRIPOS OF THE UNIVERSITY OF CAMBRIDGE

I HAVE read with great interest the papers by Mr. Glaisher in NATURE of December 2, 18, and 30, 1886 (pp. 101, 153, and 199), entitled "The Mathematical Tripos." Through the period common to Mr. Glaisher's notes and my recollections, I believe that we are strictly in agreement. I am able, however, to supply some little histories (I wish these had been more numerous and more certain) relating to transactions several years earlier than those known, personally, to Mr. Glaisher, and I am desirous that their memory should not be totally lost. There are now few persons, perhaps none, whose recollections of the University of Cambridge and of Trinity College go so far back as my own.

I first advert to the official course of undergraduates' life.

Shortly after introduction to the College in the October Term of 1819, I attended, with all other freshmen, in the Senate House or in the College Hall (I believe the latter) to take the oaths of allegiance and supremacy. With great ardour I renounced the "damnable doctrine" that the Pope of Rome could absolve subjects from their allegiance, with several similar declarations; and I also disclaimed all connection with other Universities and Colleges, and in particular with Wolsey's College at Ipswich. I believe (but have no certain knowledge) that these puerilities terminated a few years afterwards.

The undergraduates were arranged in "sides," divided under the official tutors under whom they were entered in the College Lists. There were then two "sides"; subsequently there were three. The lectures on each side were held in the College rooms of the tutor or his assistant tutor. The lectures consisted, naturally, in proposals of theorems and problems (in writing) and oral discussion of the answers in a friendly style.

The annual College examinations of the undergraduates of all sides (collected), of each year of undergraduateship, were held in the College Hall at the practical termination of the May Term. The order of merit in each year, as determined by these examinations, was published by lists of names suspended in the College Hall. Small sums of money, to be expended in honorary prizes, were assigned to the First Class of each year.

In the third year of undergraduateship arrived the time of "keeping Acts and Opponencies." These, as Mr. Glaisher has explained, were formerly the only public exhibitions of students' merits in the University; and, possibly, were still considered in the University as more important than would be gathered from Mr. Glaisher's account. The three Opponents met to take tea and to arrange their arguments; the Act also was invited, with an intimation that he was not to stop long. I have seen the "Schools," in which the disputations were held, quite filled with undergraduates of all Colleges, who came to listen to the disputations, or rather quibbles, held in the Latin language, of the argumentative quarrel. If my memory is correct, each of the undergraduates (selected, I believe, by the Moderators) appeared twice in the character of "Act" (asserting the correctness of some doctrine in the printed books), and twice or more in the character of "Opponent" (denying that correctness). The President of the School was one of the Moderators. The assertion of the Moderator that the argument failed was given by the words "Probes aliter." The discussion was usually closed by a complimentary address of the Moderator, as, for instance, "Magno ingenio argumenta tua et construxisti et defendisti." I do not think that the form lasted many years after this time.

At length came the October Term, the last term (the tenth) for undergraduates, of which I remember only one characteristic, namely, that in the College Hall a separate dinner-table was established for the "Questionists" (as those were called who were to proceed to the B.A. degree in January). To this table all Questionists were removed from whatever tables they previously occupied. Among others, the "Scholars" of the College (Trinity) were removed from their table, where they had formed agreeable acquaintances, to a collection of strangers, naturally disagreeable to the "Scholars." We much disliked this change. I think that in this term the character of the College lectures was changed almost entirely to problems and questions; some of them in the evening, in the College rooms of one of the Fellows.

At length arrived the Monday morning on which the examination for the B.A. degree was to begin. A breakfast was given by the "Father" of the College (one of the Fellows of the College) in the College Combination Room, and then we were all marched in a body to the Senate House and placed in the hands of the Moderators. How the "candidates for honours" were separated from the οἱ πολλοὶ I do not know. I presume that the Acts and Opponencies had something to do with it. The honour-candidates were divided into six groups; and of these Nos. 1 and 2 (united), Nos. 3 and 4 (united), and Nos. 5 and 6 (united), received the questions of one Moderator. No. 1, Nos. 2 and 3 (united), Nos. 4 and 5 (united), and No. 6, received those of the other Moderator. The Moderators were reversed on alternate days. There were no printed question-papers: each examiner had his bound manuscript papers of questions, and he read out his first question; each of the examinees who thought himself able proceeded to write out his answer, and then orally called out "Done." The Moderator, as soon as he thought proper, proceeded with another question. I think there was only one course of questions on each day (terminating before 3 o'clock, for the Hall dinner).

The examination continued to Friday mid-day. On Saturday morning, about 8 o'clock, the list of honours (manuscript) was nailed on the door of the Senate House.

The ceremonies and customs of conferring degrees in the middle of the day, I believe, have not been altered. The Vice-Chancellor was seated in the centre of the Senate House. The Father of that College of which the Senior Wrangler was a member led him to the Vice-Chancellor. The roar of acclamation from the undergraduates in the galleries of the Senate House, to welcome a favourite Senior Wrangler, will not be forgotten by one who has heard it. The Father presented him with the words: "Dignissime Domine, Domine Procancellarie, et tota Universitas, præsento vobis hunc juvenem, quem scio tam moribus quam doctrinâ esse idoneum ad respondendum Quæstioni; idque tibi fide meâ præsto, totique Universitati." The candidate knelt before the Vice-Chancellor, who pressed the candidate's hands between his own, and answered: "Auctoritate mihi commissâ, admitto te ad respondendum Quæstioni, in nomine Patris, et Filii, et Spiritûs Sancti." I am not able to say how much of this was repeated for each candidate. Then followed some petty quibbles with some Master of Arts concerning questions which nobody professed to understand, but which were inessential. The undergraduate gown was then changed for a B.A. gown.

On a certain day following, at a Congregation of the Senate, the list of names of those who were thus admitted was read to the Vice-Chancellor, who (as I understood) solemnly recognised the rights of the first to the privileges of Bachelor of Arts, and to each of those following only repeated the words "et ei," finally declaring that they were "actualiter in Artibus Baccalaureos."

It is evident that there must have been some relation between the various ranks which no longer exists; and, in particular, that the *Quæstio* was once important, and is now totally lost. And connections existed between the Colleges and the University which can scarcely be traced at the present day.

I now advert to the mathematical subjects of study and examination.

In the October Term, 1819, the only books on pure mathematics were: Euclid generally; "Algebra," by Dr. Wood (formerly Tutor, but, in 1819, Master, of St. John's College), Vince's "Fluxions" and Dealtry's "Fluxions," Woodhouse's and other Trigonometries. Not a whisper passed through the University generally on the subject of differential calculus, although some papers (subsequently much valued) on that subject had been written by Mr. Woodhouse, Fellow of Caius College; but their style was repulsive, and they never took hold of the University. Whewell's "Mechanics" (1819) contains a few and easy applications of the differential calculus. The books on applied mathematics were: Wood's "Mechanics," Whewell's "Mechanics," Wood's "Optics," Vince's "Hydrostatics," Vince's "Astronomy," Woodhouse's "Plane Astronomy" (perhaps rather later); the first book of Newton's "Principia." I do not remember any others. These works were undoubtedly able; and I do not conceal my opinion that for the great proportion of University students going into active life books constructed on the principles of those which I have cited were more useful than those exclusively founded on the more modern system. For those students who aimed at the mastery of results—more difficult and (in the intellectual sense) more important—the older books were quite insufficient.

More aspiring students read, and generally with much care, several parts of Newton's "Principia," Book I. and also Book III. (perhaps the noblest example of the geometrical form of cosmical theory that the world has seen). I remember some questions from Book III. proposed in the Senate House Examination, 1823.

In the October Term, 1819, I went up to the University. The works of Wood and Vince, which I have mentioned, still occupied the lecture-rooms. But a great change was in preparation for the University course of mathematics. During the great Continental war, the intercourse between men of science in England and in France had been most insignificant. But in the autumn of 1819 three members of the Senate (John Herschel, George Peacock, and Charles Babbage) had entered into the mathematical society of Paris, and brought away some of the works on pure mathematics (especially those of Lacroix) and on mechanics (principally Poisson's). In 1820 they made a translation of Lacroix's "Differential Calculus," and they prepared a volume of "Examples of the Differential and Integral Calculus." These were extensively studied; but the form of the College examinations or the University examinations was not, I think, influenced by them in the winter 1820-21 or the two following terms. But in the winter 1821-22 Peacock was one of the Moderators; and in the Senate-House Examination, January 1822, he boldly proposed a paper of important questions entirely in the differential calculus. This was considered as establishing the new system in the University. In January 1823 I think the two systems were mingled. Though I was myself subject to that examination, I grieve to say that I have forgotten many of the details, except that I well remember that some of the questions referred to Newton, Book III., on the lunar theory. To these I have already alluded.

No other work occurs to me as worthy of mention, except Woodhouse's "Lunar Theory," entirely founded on the differential calculus. The style of this book was not attractive, and it was very little read.

From this time to the times of which Mr. Glaisher treats, there were successive books on the new system, but none, I think, which can be cited as producing a marked effect in the University. G. B. AIRY

NOTES

THE University of Bologna has decided to celebrate its eight hundredth anniversary in the spring of 1888. The exact date of its foundation cannot, indeed, be determined, but all authorities on the subject agree that an important school was established at Bologna in the eleventh century. Afterwards the University took a great place as the chief centre for the study of jurisprudence, and there also anatomy was for the first time scientifically studied. The foremost Universities of Europe and America will no doubt be glad to take this opportunity of testifying their respect for so ancient and famous an institution.

AT their meeting on February 3 the President and Council of the Royal Society adopted the following resolutions concerning the publication of the Philosophical Transactions:—That the Transactions be published in two independent series, one (*a*) containing those papers which are of a mathematical or physical character, the other (*b*) those of a biological character; that the papers in each series form a yearly volume, paged continuously (though issued in parts if the Secretaries find it convenient), but that each paper be also published separately in paper covers as soon as it is ready for publication; and that Fellows have the option of receiving one or both of the yearly volumes, or, should they prefer it, each separate paper of either or both series, or the whole of one series and any separate paper of the other series, immediately on publication. These resolutions are to take effect with the volume for the present year.

A COMMITTEE, lately appointed by the College of Physicians of Edinburgh, has reported in favour of the establishment and maintenance, by the College, of a laboratory for the prosecution of original research. The Committee proposes that the College shall vote from its capital 1000*l*. for the establishment of this laboratory, and, year by year, a sum not exceeding a third of the clear surplus of annual income over annual expenditure for its maintenance, including the payment of salaries The superintendent, it is thought, should devote his time wholly to the direction and prosecution of scientific research in the laboratory; and it is suggested that an assistant experienced in microscopic work should be engaged to reside on the premises. The Committee is of opinion that the laboratory should be open without fee to Fellows of the College, to members, and to any licentiate, medical man, or investigator who may, by testimonial or otherwise, be able to show that he is a fit person to use the laboratory for purposes of scientific research. Moreover, the Committee recommends that, if there should be sufficient funds after payment of expenses, a medal and money-prize (not exceeding twenty guineas) should be offered for original work. It is understood that this admirable scheme will be adopted, and we may hope that the example set by the Edinburgh College will soon be followed by the English College of Surgeons and College of Physicians.

A CORRESPONDENT writes to us from Tashkend that on November 29 last, at 9.12 a.m., a violent shock of earthquake was felt there, accompanied by a great noise like thunder. The people were much frightened, and the majority of the buildings were more or less injured. Light shocks were felt also on December 3, and on January 9 and 16.

ON the 15th of January last there was in some parts of Japan the most severe earthquake that has been experienced there since February 22, 1880. It fetched down a number of chimneys and parts of roofs in Yokohama, but in Tokio (eighteen miles distant) it only broke a few vases and created alarm. The important and peculiar feature of the disturbance was that it had a long period and large amplitude. At the Imperial Observatory at Tokio, where a number of "Gray-Milne seismographs" are employed, the pointers of the instrument were seen to move for nearly ten minutes. We learn from the *Japan Gaz tte* that the disturbance was felt at Tokio at 6h. 51m. 59s. p.m., commencing in a series of small waves. The greatest horizontal movement was 19·2 mm. (about ¾ inch). The time taken to describe the largest wave was 2·3 seconds. The vertical motion had a range of 5·5 mm. (about ¼ inch), and its period was ·8 seconds. Altogether there were 60 distinct waves, and the maximum velocity with which the earth moved to and fro was 26 mm., or about 1 inch per second. At Tokio people felt the motion as if they had been on a slowly-moving floating pier, and in many cases it provoked a sensation of nausea. The general distribution of destruction at Yokohama was similar to that which took place in 1880. The *Japan Gazette*, however, points out that many chimneys standing on ground which in 1880 suffered severely were this time uninjured. This "anomaly," it thinks, may be explained by the fact that the owners of these chimneys took advantage of the experience they gained in 1880, and rebuilt their chimneys with a special view to their safety.

THE Right Hon. G. Sclater Booth, M.P., has accepted the Presidentship of the Congress of the Sanitary Institute of Great Britain, to be held at Bolton in September next.

ON March 6 a century will have elapsed since the birth of the celebrated optician, Joseph von Fraunhofer, at Straubing, in Lower Bavaria. Preparations are being made in Munich for the due celebration of the day.

IN the eleventh annual Report of the President of the Johns Hopkins University, Baltimore, Dr. Gilman is able to give a very satisfactory account of the progress made by the institution since its establishment in 1876. Much of its success, he thinks, is due to the system of Fellowships. Every year twenty young men who have given evidence of their attainments and of intellectual promise are selected by the authorities as Fellows, and are encouraged to devote all their time to the study of some branch of knowledge in which they have already shown proficiency. During the first ten years this honour has been bestowed upon 130 persons. Their names and the stations to which they have been called have been frequently printed, and Dr. Gilman says a scrutiny of the list will show that it contains the names of many excellent scholars. While resident at the University, the Fellows are recognised as holding an intermediate position between the Faculty and the great body of pupils. They are efficient members of the various literary and scientific associations, and occasionally give lectures on topics which they have specially studied.

A NEW quarterly journal, to be entitled the *American Journal of Psychology*, will soon be issued. Dr. G. Stanley Hall, Professor of Psychology and Pedagogics in the Johns Hopkins University, will be the editor. The *Journal* will contain original contributions of a scientific character; and articles of unusual importance will be translated from other languages, or even reprinted from other English and American publications, in full or in abstract, if not generally accessible. An attempt will be made in each number to give a conspectus of the more important psychological literature of the preceding three months, and to review significant books, bad as well as good.

A SCIENTIFIC and industrial Exhibition will be opened at Ekaterineburg in May next. The mining industries of the Ural Mountains will be well represented. Special interest will attach to the department of ethnography, as it has been arranged that there shall be in the Exhibition a number of families belonging to semi-barbarous tribes of the Ural Mountains and Siberia. Their dwellings will be exactly like those in which they usually live, and they will have with them the weapons and implements used by them in hunting and fishing. Another important element will be a collection of ancient objects in stone, bone, clay, and metal, found in Siberia and among the Ural Mountains. These objects have never before been publicly exhibited.

A CAUCASIAN Agricultural Exhibition will be held next year in Tiflis. Products of the animal, vegetable, and mineral kingdoms will be exhibited.

FISH-HATCHING operations have begun at the Buckland Museum, where consignments of trout ova, presented by Sir James Maitland, have been laid down in the incubating apparatus used by the late Mr. Frank Buckland. The system upon which the ova are hatched at the Museum is that known as the "overflow," the water passing over the eggs, which are placed in slate boxes lined with gravel. The new system is called the "underflow," the water passing underneath the eggs, which are deposited in perforated zinc trays without gravel. Much diversity of opinion exists as to the efficacy of the two systems.

THE other day some workmen, while removing brickwork that had surrounded a tank in the late South Kensington Aquarium, found ten eels secreted in a crevice of the masonry, which was perfectly dry. The tank had been removed eighteen days before, when the Aquarium was dismantled, so that the fish must have been without water during the whole of that time. When placed in water they appeared to have been in no way injured by their terrestrial experience.

IN the debate on the appropriations for the support of the U.S. Coast Survey, the Senate, according to *Science*, pared the items down in a parsimonious spirit. Afterwards the Senate Appropriations Committee addressed a letter to the Secretary of the Treasury, inquiring whether the estimates as submitted by the Superintendent of the Coast Survey were satisfactory to that Department. The answer was that they were perfectly satisfactory, and a communication from the Superintendent of the Coast Survey was submitted, showing the reasons for each item of expenditure, and the present condition of the service. "From these communications," wrote the Secretary, "it appears that the estimates made provision for the efficient and economical prosecution of the Survey during the ensuing year; it also appears that the provision made by the House Bill will not secure such results. Consequently the arrangement made is not satisfactory to this Department."

WE learn from Italy that the idea of boring a tunnel between the peninsula and Sicily has been revived. The estimated cost is said to be seventy-one millions of francs, and the time required for completing the work would be from four to six years. It is stated that the depth of the sea is 160 metres.

THE number of foreigners at present residing in France, and settled there, is 1,115,214, against 37,103,689 Frenchmen. The parts of France in which the foreigners are most numerous are of course the frontier departments, those of the Nord, Alpes Maritimes, Var, Bouches du Rhône, &c. In the Seine Department there are 213,529 foreigners; in the Nord 305,524, most of whom are Belgians.

OYSTER-PRODUCTION, although carried on to a large extent in France, is not yet a profitable investment. The reason is that the rates for transportation from the oyster-beds are too high. In Auray, for instance, oysters are worth nine francs per thousand; in Paris they cost more than fifty francs. An attempt is being made to secure transportation at less cost.

A MOVEMENT is on foot in the North Sea towns of Germany for promoting oyster-culture along the coast, supported by Government grants. At present there are fifty-one banks in the North Sea, viz. twenty-six at Fanö, Romö, and Sylt, and twenty-five at Föhr, Amrum, and Hallingerne. In the Baltic, on the other hand, all attempts at oyster-culture have failed. "Holstein" or "Flensburg" oysters—considered the best in Germany—are really English or Dutch. All the German oyster-banks are the property of the State, and leased to private individuals.

WE regret to announce the death of Dr. Walfried Marx, Professor of Descriptive Geometry at the Technical High School at Munich. He died on February 10.

THE first International Horticultural Exhibition will be held at Dresden on May 7.

HERE is a case in which even a little knowledge of physics would not have been out of place. A man was summoned for making use of the communication between passengers and guard without reasonable and sufficient cause. Being in a third-class compartment alone, he was frightened by the singing noise of his foot-warmer, caused by the contraction of metal due to the reduction of temperature. Thinking it an infernal machine, he immediately threw it out of the window, and, not content with this drastic proceeding, he incontinently proceeded to stop the train by using the excellent mode of communicating with the guard and engine-driver which exists on the South-Eastern Railway. A little more science and a little less energy would have saved everybody a little trouble, but as his *bona fides* was as obvious as his ignorance, the magistrate dismissed him with a caution. The magistrate might, perhaps, have done some good if he had told the man what happens when an ordinary kettle is filled with ordinary water and placed on an ordinary fire.

IN a recent number, *Science* referred to a supposition that "it is change of diet which is the most potent remote cause of consumption among the Indians." Mr. H. C. Wyman, of Detroit, writes to that journal that, in his opinion, another cause is change change of dress. "If," says Mr. Wyman, "a live rabbit be dipped in a solution of glue, so as to cover its body with a coating impervious to air, it is surprising how quickly the frequency of the respiratory movements increases, showing that the work of the lungs is increased by depriving the skin of free access to the air. The process of civilisation has a somewhat similar effect upon the Indian, though to a less degree. One of the first lessons in the effort to civilise him teaches him to envelop himself in clothing of a kind that tends to impede and impair the normal action of the skin, the pores of which are organs of excretion—a mechanism by which morbid and waste material may be thrown out of the system. Deprived of the assistance afforded under previous conditions by the skin, the work of the lungs is greatly increased, rendering them peculiarly susceptible to bronchitis and pneumonia—ailments which are commonly the forerunners of consumption. If we accept the theory of Koch, they make the lungs a suitable habitation for the *Bacillus tuberculosis*." Mr. Wyman contends that, in the case of civilised races, the liability to consumption from overworked lungs has been tempered by hundreds of generations of ancestors habituated to the use of clothing.

IN the Report of the U.S. Geological Survey on the mineral resources of the United States for 1885, it is stated that the total mineral product is valued at 428,521,356 dollars, an increase of 15,306,608 dollars over 1884. Among seventy mineral substances cited, coal is the most important, showing a total value of 159,019,596 dollars. An increase is shown in the production of coke, natural gas, gold, silver, copper, zinc, quicksilver, nickel, aluminium, lime, salt, cement, phosphate rock, manganese, and cobalt oxide, while the production of coal, petroleum, pig-iron, lead, precious stones, and mineral waters decreased. According to the Report, it is probable that the total output of 1886 was much greater than that of 1885, and even larger than that of 1882.

WE have received the *Annuaire* for 1887 of the Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. It contains a full account of the organisation of the Academy, and of the means by which it seeks to encourage science, literature, and art. Among the biographical notices are articles on the late François Lenormant and Edouard Morren.

AN illustrated work, entitled "Les Civilisations de l'Inde," by Dr. Gustave Le Bon, is being issued in weekly parts by Firmin-Didot et Cie. Dr. Gustave Le Bon is the author of a work on "La Civilisation des Arabes."

THE Calendar of the Imperial University of Japan for the current year, which we have just received, deserves special mention, for it is the first that has been issued since the amalgamation of the well-known College of Engineering and the University of Tokio into the single institution which forms the new University. This incorporation was made the occasion for several organic changes, one of which is the almost total elimination of Europeans from the teaching staff, their places being taken by Japanese. To understand the full extent of the change in this respect, it is necessary to remember that five or six years ago all the professors in the College of Engineering, and nearly all in the University, were Europeans. An examination of the Calendar shows how the new University stands in this respect. By the Imperial decree, which is the charter of the institution, the Council of Professors regulate the studies and generally look after the interests of the University and each of its Colleges. There is not a single Western amongst the nine Councillors. In the Law College, three out of thirteen professors and lecturers are Westerns; in the Medical Faculty, out of thirty-four professors and assistants, there are three Europeans; there are three Europeans amongst twenty-four professors and assistants in the Faculty of Engineering; two in twenty-six in Science; and three in nineteen in Literature. It is probably not too much to say that, where one European is teaching now, there were six Europeans five years ago. It was only to be expected that ultimately the Japanese would have their own men ready to take the places vacated by Europeans. They had at vast expense sent abroad large numbers of youths to be educated for the various professions in Europe and America, who, on their return, were competent to teach their countrymen; and in looking down the lists of the Japanese professors we see that most of them have foreign degrees and other qualifications. They come from almost every German, French, British, and American University, and in some instances have taken high honours. They may therefore be presumed to be competent for the work which they have undertaken, and there is no special reason to believe that the step taken by the Minister of Public Instruction in placing the higher education of the country in the hands of his countrymen is premature. Be this as it may, it is clear that the day of Europeans in Japanese education is past, and this fact is only emphasised by the few familiar names amongst a host of unfamiliar ones in the list of the University. Moreover, even where there are one or two foreign professors, the direction is all in Japanese hands. The Director and the chief Professor in every Faculty are Japanese, so that if the individuals are fewer in number, the functions and status of each one remaining have also diminished. Time alone will show whether the experiment—for undoubtedly the Imperial University is at present in the experimental stage—will be successful or not. He would be a bold man who, for example, prophesied that the Faculty of Engineering in the new University will maintain the high position won for the old Imperial College of Engineering in the world of science by a body of brilliant European professors, some of whom are now in the front rank at home. In the Calendar there is certainly evidence of much activity. An Astronomical Observatory has been fitted up for the instruction of the students; there is also a Seismological Observatory, with horizontal pendulum and vertical-motion seismographs. By the aid of a complete set of these instruments now in the Observatory, it is possible to measure earth-movements of different grades of magnitude. In addition, a system of telegraphic communication with different parts of the city extends the area of observation. A Botanic Garden and a small Marine Biological Laboratory are likewise attached to the Science Department.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, presented by Mr. Julius Wilson; a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Capt. Larmer, s.s. *Trojan*; a Crowned Hawk Eagle (*Spizaetus coronatus*) from Natal, presented by Colonel H. Bowker, F.Z.S.; a Spotted Eagle Owl (*Bubo maculosa*) from South Africa, presented by Mr. H. Justice; a Brazilian Hangnest (*Icterus jamaicai*) from Brazil, presented by Mr. W. G. Little Gilmour; two Crossbills (*Loxia curvirostris*), British, presented by Mr. W. H. St. Quintin; two White-fronted Lemurs (*Lemur albifrons*) from Madagascar, deposited; a —— Capuchin (*Cebus* ——) from South America; two Chimachima Milvagos (*Milvago chimachima*) from Brazil, purchased.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR δ EQUULEI.—This close and rapid binary, which was discovered in 1852 by M. O. Struve, and measured on a number of nights between that time and 1874, was supposed by its discoverer to have a period of between 6 and 7 years or one of about 13 years. More recently, Mr. Burnham, who observed the star between 1880 and 1883, concluded from an examination of all the measures that the period was about 10·8 years. It is therefore the most rapid binary now known. At the request of Prof. Glasenapp of St. Petersburg, Herr Wrublewsky (*Astron. Nachr.* No. 2771) has computed a set of elements from all the available observations. He finds the time of periastron passage to be 1892·03, with eccentricity = 0·2011, mean distance, = 0″·406 and period = 11·478 years. These elements do not, however, represent the observed position-angles satisfactorily, and it is desirable that the possessors of sufficiently powerful telescopes should pay some attention to this very interesting object, especially at the present time, when the components are about at their maximum distance apart. Herr Wrublewsky's orbit gives, for 1887·24, position-angle = 204°·9, and distance = 0″·48.

THE TEMPLE OBSERVATORY.—From the Report of Mr. Seabroke, honorary Curator of the Temple Observatory, Rugby, we learn that during 1886 Mr. Percy Smith continued the measurement of position-angles and distances of double stars, 88 sets of measures having been secured. These stars have been divided into three categories for future re-measurement, viz. rapid binaries, to be observed every year; slower binaries, to be observed every 4 years; and long-period binaries, to be observed every 10 years. Mr. Seabroke himself has continued the measurement of the motion of stars in the line of sight with the spectroscope on the reflector, and has completed 100 sets of measures. These observations, together with the corresponding ones for previous years, have been published in the January number of the *Monthly Notices*.

DISCOVERY OF A NEW COMET, 1887*d* (BARNARD 2).—A new comet was discovered on February 15 by Mr. E. E. Barnard, Nashville, Tennessee. It was very faint, and was moving rapidly in a north-westerly direction. At midnight (local time) its position was R.A. 8h. 4m., Decl. 16° 10′ S.

PROBABLE NEW VARIABLE.—We learn from Circular No. 15 of the Liverpool Astronomical Society, that Mr. Backhouse finds 28 Andromedæ to be probably variable within small limits. The observations yet obtained are insufficient to fix the period, which must, however, be short. It is possible that the star is of the Algol type.

NAMES OF MINOR PLANETS.—Herr J. Palisa has named Minor Planet No. 256 Walpurga.

BRIGHTNESS AND MASS OF BINARY STARS.—The current number of the *Observatory* contains an article on this subject by Mr. W. H. S. Monck, in which he attempts to deduce the relative brilliancy of those binaries for which the orbits are best determined. Assuming that the mass of the companion-star is very small as compared with that of its primary, he shows that the relative brilliancy of any two pairs of binaries may be found by the following formula:—

$$\frac{k_1}{k_2} = \left(\frac{I_1}{I_2}\right) \cdot \left(\frac{P_1}{P_2}\right)^{\frac{4}{3}} \cdot \left(\frac{a_2}{a_1}\right)^2,$$

where $I_1 I_2$ stand for the total amount of light, as determined photometrically, which we receive from the two pairs respectively; $P_1 P_2$ for their periods; and $a_1 a_2$ for the angular radii of their orbits. By, apparently, a printer's error, the index of $\left(\frac{P_1}{P_2}\right)$ is omitted in the formula in the *Observatory*. Adopting ξ Ursæ Majoris as his unit of comparison, Mr. Monck finds the brilliancy of γ Leonis 93·29; of Castor, 38·24; δ Cygni, 35·52; of Sirius, 7·17; 42 Comæ, 2·79; 6 (*p*) Eridani, 0·20; and 61 Cygni, 0·08. It is noteworthy that Prof. E. C. Pickering, in a paper which appeared in the Proceedings of the American Academy of Arts and Sciences, vol. viii. No. 1, obtained very similar results for many of the same stars, but by a somewhat different process. In both lists γ Leonis figures at the head, followed by Castor and δ Cygni, whilst the smallest values are found for *p* Eridani and 61 Cygni. The weak point in Mr. Monck's computation is the assumption that the mass of the smaller star is comparatively insensible; the near equality in magnitude of many of the binaries selected would seem to indicate that the assumption was not a safe one. Mr. Monck repeats Prof. Pickering's suggestion that series of careful measurements should be made between each component of the binary systems and some neighbouring stars, so that the ratio of the masses of the two components may be determined. It is to be hoped that some double-star observers may be induced to take up this interesting subject, now that attention has again been called to its importance. The research might also possibly supply us in some cases with a determination of the distance of the binary.

THE LIVERPOOL ASTRONOMICAL SOCIETY.—The Pernambuco branch of this Society now numbers more than eighty members, and has been accorded permission to elect a local executive. The Emperor of Brazil has been elected a member of the Society.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *FEBRUARY* 27—*MARCH* 5

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 27

Sun rises, 6h. 52m.; souths, 12h. 12m. 56·0s.; sets, 17h. 34m.; decl. on meridian, 8° 21′ S.: Sidereal Time at Sunset, 4h. 3m.

Moon (at First Quarter March 3) rises, 8h. 50m.; souths, 15h. 30m.; sets, 22h. 21m.; decl. on meridian, 7° 9′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	7 17	13 13	19 9	1 36 S.
Venus ...	7 34	13 31	19 28	1 23 S.
Mars ...	7 19	13 1	18 43	4 11 S.
Jupiter ...	22 48*	3 49	8 50	12 8 S.
Saturn ...	12 30	20 39	4 48*	22 25 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
2	Aldebaran	1	17 47	18 4	182 210
4	130 Tauri	6	2 30	2 38	43 25

March	h.	
3	3	Mercury at least distance from the Sun.
5	11	Mercury at greatest elongation from the Sun, 18° east.
5	14	Saturn in conjunction with and 3° 29′ north of the Moon.

Variable Stars

Star	R.A.	Decl.		
	h. m.	° ′		h. m.
U Cephei ...	0 52·3	81 16 N.	Mar. 2,	19 57 *m*
Algol ...	3 0·8	40 31 N.	Feb. 28,	2 54 *m*
			Mar. 2,	23 43 *m*
U Monocerotis ...	7 25·4	9 33 S.	Feb. 28,	*m*
T Canis Minoris ...	7 27·7	11 59 N.	,, 28,	*M*
S Cancri ...	8 37·5	19 26 N.	Mar. 2,	23 26 *m*
R Leonis ...	9 41·5	11 57 N.	,, 2,	*m*
U Virginis ...	12 45·4	6 10 N.	,, 5,	*m*
W Virginis ...	13 20·2	2 48 S.	,, 4,	0 0 *m*
S Boötis ...	14 19·3	54 20 N.	,, 2,	*M*
δ Libræ ...	14 54·9	8 4 S.	,, 3,	0 5 *m*
U Coronæ ...	15 13·6	32 4 N.	Feb. 27,	21 2 *m*
U Ophiuchi ...	17 10·8	1 20 N.	Mar. 3,	1 8 *m*
			and at intervals of	20 8
W Sagittarii ...	17 57·8	29 35 S.	Mar. 3,	4 0 *m*
R Scuti ...	18 41·5	5 50 S.	,, 3,	*M*
β Lyræ ...	18 45·9	33 14 N.	,, 5,	20 0 *M*
R Lyræ ...	18 51·9	43 48 N.	Feb. 28,	*M*
δ Cephei ...	22 25·0	57 50 N.	Mar. 2,	23 0 *M*

M signifies maximum; *m* minimum.

Meteor-Showers

Amongst the meteor-showers of the season are the two following:—Near δ Virginis, R.A. 192°, Decl. 1° N.; near ξ Sagittarii, R.A. 280°, Decl. 17° S. The latter radiant gives very swift streak-bearing meteors.

GEOGRAPHICAL NOTES

TWO letters have been received in Vienna from Dr. O. Lenz, dated, one from Lake Tanganyika in September, and the other from the River Shiré in December. This indicates that the Austrian Expedition has taken an unexpected route to the east coast. When Lenz and his companions left Kasonge, on the Upper Congo, on June 30, they made for Tanganyika, arriving at Capt. Hore's station on the west shore on August 7. Crossing to Ujiji, Dr. Lenz found that it was impossible to proceed northwards to the Albert Nyanza and Emin Pasha, on account of the Arab raids and the state of things in Uganda. Instead, therefore, of proceeding eastwards to Zanzibar, he travelled, by land apparently, to the south end of Lake Tanganyika, along the Stevenson road to Lake Nyassa, down that lake to the Shiré, and thence by the Zambesi to Quillimane. The two letters will be published in the next number of the *Mitteilungen* of the Vienna Society, and will doubtless contain a good deal of information of interest.

TIPPOO TIP, about whom we have heard so much recently in connection with the Emin Pasha expedition, seems to be rather an intelligent man, and even finds time in the midst of his ivory raids to attend to the interests of science. He recently came upon a remarkable tribe on the Congo, to the north of Nyangwé, who do a great deal of work in copper, and whose inlaid work in that metal is of a highly artistic character. He sent several specimens to an English friend at Zanzibar, who has brought them with him to this country. Still more interesting is the discovery by Tippoo, among the same people, of what may be regarded as the first steps towards a currency. Spears are naturally among the most valuable articles which such a people possess, and, as a matter of fact, the value of everything is reckoned by them in terms of spears. Not only so, but they have actually reached the stage of a conventional currency. Enormous spear-heads of very thin copper are made, some six feet in length, which are passed from hand to hand, just as bank-notes are with us. These spears, for example, in the purchase of ivory, are valued at £200—their intrinsic value being probably not so many pence. We are glad to know that a specimen is likely to be deposited in the British Museum. Readers of Schweinfurth's "Heart of Africa" will remember that among the Niam-Niams hoes are used for a similar purpose, only after a reverse fashion; tiny hoes, what we should call mere toys, are in common use as money.

THE principal article in the new number of *Petermann's Mitteilungen* is a summary of the journey across Africa from Mossamedes to Quillimane, by the Portuguese travellers, MM. Capello and Ivens in 1884-85. The most valuable geographical work accomplished by the travellers was the exploration of the interesting region lying between the Upper Zambesi and Lake Bangweolo. The important north-east tributary of the Zambesi, the Kabompo, was traced to its source in the closest proximity to the sources of the Lualaba, one of the most important contributories to the Congo. From here a zigzag was made eastwards and southwards, across the head-waters of many affluents of the Zambesi, until that river was reached about 16° S. and 29° E. MM. Capello and Ivens took very numerous astronomical and meteorological observations during their journey, as well as observations for terrestrial magnetism. The complete narrative of the journey, with ample supply of maps and scientific appendixes, has just been published in Portuguese. The same number of the *Mitteilungen* contains a large collection of barometric data on the hypsometry of South America, mainly Peru and Bolivia.

PROF. L. BODIO sends to the *Bollettino* of the Italian Geographical Society for December 1886 an important paper on Italian emigration, which he divides into two categories—permanent and temporary. The latter, which is essentially of a periodical character, varies from 80,000 to 100,000 persons yearly, and consists chiefly of stonemasons, bricklayers, navvies, and other day-labourers from the northern provinces of Piedmont, Lombardy, and Venice, who seek casual employment on the public works in Austria, France, Germany, Switzerland, Corsica, and elsewhere. They generally leave their homes in the spring, returning with their earnings towards the close of autumn, and enjoy the reputation of sober, steady, intelligent workmen. The permanent movement, which alone constitutes emigration properly so called, has already risen during the last twenty years from less than 20,000 to about 80,000 annually, and is directed from the same northern provinces, and from Liguria and parts of Naples, almost exclusively to the Argentine States and some other parts of the New World. The emigrants, who sail either directly from Genoa, Naples, and Palermo, or from the French ports of Marseilles, Bordeaux, and Havre, comprise between 60 and 80 per cent. of male adults, the small minority consisting of women and children. They represent nearly all social conditions, the peasant class, however, largely predominating in South America. For the year 1885 the returns show 57,827 to the Argentine Republic; 15,485 to the United States; 12,311 to Brazil; and 1477 to Uruguay. The chief inducements to leave their native land and settle abroad appear to be poverty, the desire to better their fortunes, and the direct encouragement of friends and relatives who have prospered in their new homes across the Atlantic. Very few ever return to reside permanently in the mother country.

THE Germans are losing no time in making themselves acquainted with the section of New Guinea which they have annexed. The Empress Augusta River, close to the western boundary of the German territory, was recently navigated by Admiral von Schleinitz and Dr. Schrader, in the steamer *Ottilie*, for a distance of 224 miles. It being the dry season, the river was too shallow for further navigation by the steamer. The ship's steam-launch, however, proceeded 112 miles further, to a point situated in 4° 16′ S. and 141° 50′ E.; judging from the quantity of water in the river the voyage could have been continued 50 miles further, but fuel ran short. For over 200 miles from its mouth the river flows through extensive plains; then its course suddenly changes, and it assumes the character of a mountain stream, forcing its way through hills of gneiss, mica-slate, and quartz; but the velocity of its current remains uniform. The settlements on its banks were only found at long intervals.

ON THE CONSTITUTION OF THE NITROGENOUS ORGANIC MATTER OF SOILS

THE organic matter of soils, the residue of the limited oxidation of vegetable and animal matter, has appeared a subject so complex and obscure, and promising the investigator so little of definite result, that it has received but scanty attention. The researches made have been chiefly confined to a study of the non-nitrogenous humic acids, the nitrogenous organic bodies present in soil have been scarcely at all investigated. The agricultural chemist has indeed not unfrequently spoken and written as if such investigation was superfluous, holding that the nitrogenous organic bodies contained in humus were not capable of serving as food for farm crops until they had undergone a further change into ammonia, and finally into nitric acid. A valuable paper, "Sur les principes azotés de la terre végétale," by Berthelot and André, which appeared in the *Comptes rendus* of December 6, has called attention to this neglected subject, and has done much to clear up our ideas respecting the constitution of the nitrogenous organic matter contained in soils. Like many other epoch-making treatises, the paper in question brings forward facts which have, in part, been already established by earlier investigators; but in no earlier investigation, as far as I am aware, have the facts appeared in such a striking aspect, nor have the conclusions which flow from them been clearly set forth.

Berthelot and André conclude that the nitrogenous matter of soils is mainly composed of insoluble amides;[1] these amides are decomposable by the action of acids, alkalies, and to a less extent by water, into ammonia and soluble amides (amido-acids), in the same manner as other bodies of the same class with which the chemist is already quite familiar. The behaviour of soil towards hydrochloric acid furnishes the main facts on which the French chemists base their conclusions. They find that when a soil tolerably rich in nitrogen (0·174 per cent.) is treated with dilute hydrochloric acid, a quantity of ammonia is found in the solution, which is greater as the strength of the acid is increased, as the time of its action is lengthened, and especially as the temperature is raised; two hours' boiling produces, in fact, with various strengths of acid, four, five, and six times as much ammonia as five days' action in the cold. Besides ammonia, there is found in the acid solution a considerable quantity of some nitrogenous organic body, the amount of which rises and falls with the quantity of the ammonia. In cases in which the action of the acid was carried farthest, the nitrogen of the soluble organic body bore to the nitrogen of the ammonia a proportion of about 3 to 1. The extent to which the nitrogenous matter of the soil was attacked by the hydrochloric acid was very considerable; boiling 200 grammes of soil for two hours with 400 cubic centimetres of water, and 100 cubic centimetres of strong hydrochloric acid, resulted in the solution of 31·8 per cent. of the soil nitrogen, and the conversion of 7·1 per cent. of it into ammonia. The nature of the nitrogenous organic matter found in solution in the hydrochloric acid has apparently not been particularly investigated by Berthelot and André, but the whole reaction is so characteristic of the splitting up of an amide that their view of the constitution of this body becomes highly probable.

Investigations earlier than those of Berthelot had shown that hydrochloric acid dissolves nitrogenous matter from the soil. Loges has pointed out that this solution contains a nitrogenous body precipitable by phospho-tungstic acid. The nitrogen and carbon in this precipitate had a relation of about 1 to 6·2. My own experiments show that a nitrogenous body precipitable by phospho-tungstic acid is also extracted from soil by a cold

[1] The presence of amides in soil was long ago inferred by S. W. Johnsor ("How Crops Feed," p. 247), from the reactions of soil with which chemists were then acquainted.

solution of potassium carbonate. We may hope that, before long, further light will be thrown on the constitution of these bodies.

The action of alkalies on soil is quite in accordance with the assumption of the amide nature of its nitrogenous compounds. Boussingault long ago showed that the agricultural operation of liming a soil caused the production of ammonia. It has recently been shown by Baumann, and others, that a solution of soda, even in the cold, develops a notable amount of ammonia in soil, while at a high temperature the action becomes very considerable.

Nor are facts wanting which seem to exhibit the actual synthesis of amides from ammonia and humic acids. Knop long ago observed that when peat was treated with ammonia the ammonia disappeared, and could no longer be detected. Joulie found, in his experiments on the changes which take place in farmyard manure, that when finely divided straw, horse-dung, and ammoniacal urine of known composition were mixed, and allowed to ferment, a great disappearance of ammonia took place, accompanied by a gain of 35 to 63 per cent. in the organic nitrogen. The ammonia had in this case clearly united with some of the organic compounds present.

The view of the constitution of the nitrogenous matter of the soil which has been now brought forward will, we think, prove fruitful: it throws much light on the chemical changes within the soil; it has also possibly important bearings on plant-nutrition. That the acid sap contained in roots is capable of rendering soluble, and thus effecting the assimilation of various mineral matters with which they come in contact, is admitted to be a fact by physiologists. May it not equally follow that the insoluble amides of the soil are also attacked by the acid root-sap? We know not yet the properties of the soluble amides which result from the action of acids on the insoluble amides of the soil; but if they are diffusible through a membrane, they must enter the plant, and it is certainly very probable that they would then be found capable of taking part in plant-nutrition. A reaction of the kind we have supposed between the root and the soil would probably take place to a very different extent with different plants, much depending on the character of the root-sap. When the subject has been more fully investigated, it may perhaps be found that we have in this action of the roots an explanation of those obscure cases of plant-nutrition which at present puzzle the agricultural chemist. R. WARINGTON

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following is the speech delivered by the Public Orator, Dr. Sandys, in presenting for the honorary degree of Doctor of Science, Prof. Alexander Agassiz, Curator of the Museum of Zoology, Harvard College, Massachusetts:—

Cum Collegio Harvardiano antiquitus consociati, nuper vetera amicitiae iura auspiciis optimis renovavimus; litteris datis acceptisque trans maria lata dextras iunximus; legatis denique insignibus missis, ludis illis saecularibus, etiam absentes, velut praesentes interfuimus. Hodie vero e Collegii illius professoribus unum revera praesentem videmus, virum et suo et patris et Collegii sui nomine nobis dilectum. Donec Alpium inter culmina ingentes illae glaciei moles desuper paullatim descendunt, tam diu patris illius nomen superstes vivet, qui, in Republica non magna natus, Rempublicam maximam gloriae suae fecit participem, expertus scilicet vetera illa verba quam vera essent:—

"Omne solum forti patria est, ut piscibus aequor,
Ut volucri vacuo quicquid in orbe patet."

Filii vero famam patre tanto non indignam, quibus potissimum verbis exsequi potero? Utinam tu mihi hodie adesses:—

O testudinis aureae
Dulcem quae strepitum, Pieri, temperas;
O mutis quoque piscibus
Donatura cycni, si libeat, sonum.

Atqui Musa illa vocata non audit; rogata tacet; virumque praeconio altiore dignum sermone pedestri laudandum relinquit. Ergo, utcunque possumus, virum libenter laudamus, qui, cum ingenii sui ope aeris thesaurum ingentem invenisset, Academiam suam divitiarum suarum amplitudine ornavit, iudice me (insusurrare mihi videtur Horatius) iudice me, "non sordidus auctor naturae verique." Quid autem de vivario illo dicam, aequoris Atlantici prope marginem ulteriorem condito, ubi maris immensi miracula minutissima ab hoc viro accuratissime examinantur, ubi oceani ipsius e penetralibus profundis rerum naturae veritas ipsa audacter extorquetur? Satis erit hodie de veritate illa dicere quod olim de Romanorum virtute dictum est:—

"Merses profundo; pulchrior evenit."

Duco ad vos marinae praesertim zoologiae indagatorem indefessum, ALEXANDRUM AGASSIZ.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopial Science*, January.—The anatomy of the Madreporian coral Fungia, by G. C. Bourne (plates xxiii. to xxv.). During a visit to Diego Garcia (an atoll lying in 7° 13′ S. lat., 72° 23′ E. long.) which extended from the middle of September 1885 to the middle of January 1886, the author was able to collect and preserve a large number of specimens of *Fungia dentata*. These Fungiæ were very abundant within the lagoon, where at low spring tides they could be collected by scores from depths of from three to ten feet: a prolonged search failed to secure any specimens under two inches in diameter, or an example of the nurse-stock. It is suggested that the time of the year was the cause of this; the depth of the water in which the search had to be made was also unfortunate for such investigations. The name "mesoglœa," suggested by Prof. Lankester, is used to denote the supporting lamina of Cœlenterata: the only seeming objection to the name is that it is the name of a well-known genus of Algæ.—On some points in the development of *Petromyzon fluviatilis*, by Arthur E. Shipley (plates xxvi. to xxix.). The material was obtained by fertilising the eggs of the ripe female Lampern, hatching the larvæ out, and rearing them in confinement. The summary is too long for abstracting, but it may be mentioned that the early development of the skeleton is described up to the stage where Prof. Parker commenced his researches.—The ammoniacal decomposition of urine, by Dr. W. R. Smith (plate xxx.). Records a series of observations proving that the ammoniacal decomposition of urine is brought about by the presence of a Micrococcus which differs from that described by Prof. W. Leube, inasmuch as it liquefies gelatine. Though about twenty different organisms were isolated from one sample of healthy urine, only this one acted so.—Notes on Echinoderm morphology, No. 10; on the supposed presence of symbiotic Algæ in *Antedon rosacea*, by P. Herbert Carpenter (plate xxx.). Discusses the views of Vogt and Yung as to the Sacculi of Antedon being symbiotic Algæ, and considers these views as certainly not proven; an opinion which Perrier seems by intuition to have already ascribed to him.—The function of nettle-cells, by Dr. R. von Lendenfeld (plate xxx.). The plasmotic contractile coat of the cnidoblast is incited to action by the cnidocil: the animal can control this action.—Some new methods of using the aniline dyes for staining Bacteria, by E. H. Hankin. Illustrations of the structure and life-history of *Phytophthora infestans*, by Prof. H. Marshall Ward (plates xxxi. and xxxii.).—On the formation and liberation of the zoospores in the Saprolegnieæ, by Dr. Marcus M. Hartog.

THE *Journal of Botany* for January is chiefly occupied by a biographical notice of the late Dr. H. F. Hance, of Whampoa.—In the number for February, Dr. Richard Spruce describes and figures a Hepatica from Killarney new to science, to which he gives the name *Lejeunea Holtii*; Mr. Alfred Fryer continues his notes on the genus *Potamogeton*; and Mr. J. G. Baker commences a synopsis of the six genera *Sodiroa*, *Caraguata*, *Schlumbergeria*, *Guzmannia*, *Catopsis*, and *Tillandsia*, which make up the tribe Tillandsieæ of the natural order Bromeliaceæ.

Bulletin de l'Académie Royale de Belgique, December 1886.—Determination of the parallax relative to the larger member of the double star Σ 1516 of Struve, by L. de Ball. From previous observations the chief star of this group appeared to have a proper movement in a straight line independently of its companion, with which it had no physical connection. By means of a Cointe refractor the author has followed the relative displacements of the two stars, and has determined a periodicity, the effect of the relative parallax, which he finds to be

$$0''{\cdot}091 \pm 0''{\cdot}013,$$

and the distances

$$0''{\cdot}112 \pm 0''{\cdot}010.$$

From these elements he determines an absolute parallax 0″·104, with a mean error 0″·008, corresponding to a distance which light would take 31 years to traverse.—Note on the transparency of platina mirrors, by Edm. Van Aubel. His further researches confirm the author's previous conclusions regarding the false transparency of these mirrors, the light passing, not through the metal itself, but through the interstices left between the particles deposited on the plates as prepared by Paul Lohmann, of Berlin.—On the instability of equilibrium of the surface-layer of a liquid, second part, by G. Van der Mensbrugghe. The points here dealt with are: (1) the existence of a surface-tension proper to each liquid according to a given inner temperature; (2) the existence of a contractile or expansive force on the surface of a liquid in contact with a solid; (3) tension of a surface common to two liquids not intermingling.—On the valency of an atom of carbon, by Louis Henry. A method is proposed for determining the relative value of the four unities of its chemical action.—On the physiology of the heart of the dog, by Léon Fredericq. The author explains the nature of the contraction of the ventricles, the idio-muscular contraction of the cardiac muscle, the nervous system of the heart, its isolated circulation, and the circulation in the pulmonary artery.—The Neanderthal or Canstadt race in Belgium, by MM. Traipont and Lohest. The authors describe what appears to be the most important anthropological find ever made in Belgium. It consists of two more or less perfect human skeletons discovered by them in association with the remains of *Rhinoceros tichorinus*, *Elephas primigenius*, the cave hyæna, and other extinct animals in the undisturbed Lower Quaternary deposits of a limestone cave at Spy, on the banks of the Orneau, in the province of Namur. The human remains, which came to light during the summer of last year, present remarkable points of resemblance with those of the oldest yet discovered Palæolithic race, as represented by the Neanderthal and Canstadt skulls. The relationship is so close that the strikingly simian features of these skulls, hitherto regarded as possibly aberrant or pathological, would appear to be perfectly normal, and characteristic of the oldest known human inhabitants of Western and Central Europe. One of the skulls of the Spy men is decidedly platidolichocephalic (long and low), with cephalic index 70; the other is sub-platidolichocephalic, with index 74·80. The frontal bone is also very low, narrow, and retreating, and the upper alveolar process highly prognathous, while the chin is but slightly developed, receding more rapidly than that of even the lowest Papuan type.

Engler's Botanische Jahrbücher, Achter Band, 1 Heft.—The latest botanical discoveries in the tombs of Egypt, by G. Schweinfurth. This article, with an appendix dated October 1886, contains an enumeration and description of vegetable remains found in tombs at Dra-Abu'n-Negga. Though the specimens were often in bad preservation, the author has been able to recognise some fifty species of plants from tombs dating from various periods, both very ancient and comparatively modern; among others the garlic (*Allium sativum*), which, with leeks and onions, is mentioned in Numbers, chap. xi.—The next two articles by Alfredo Cogniaux and Dr. F. W. Klatt contain descriptions of the Melastomaceæ, Cucurbitaceæ, and Compositæ collected by Lehmann in Guatemala, Costa Rica, and Columbia.—On the family of the Lactoridaceæ, by A. Engler. The genus Lactoris has been placed by various authors in the Magnoliaceæ, Dilleniaceæ, and Piperaceæ (Sauruaceæ). On anatomical as well as other grounds the author rejects the affinity to the Saururaceæ and Dilleniaceæ, and concludes that Lactoris is to be regarded as representing a family (Lactoridaceæ) closely allied to the Magnoliaceæ.—On Didymia, a new genus of Cyperaceæ, by Dr. R. A. Philippi (with one plate).—Contributions to the flora of the Congo district collected by Dr. Naumann on the expedition of H.M.S. *Gazelle*, prepared by A. Engler.—Then follow abstracts of papers published elsewhere.—At the conclusion of this number is a formal offer of prizes for monographs of the genera Ranunculus and Draba, and for a critical revision of the fossil forms of Quercus.

Achter Band, 2 Heft.—Dr. R. A. Philippi, on the Chilian species of Polyachyrus, a genus of Compositæ belonging exclusively to Chili and Peru. The author distinguishes the species according to the characters of the leaves, and illustrates his paper with a plate.—Hepaticæ Africanæ, by F. Stephani (one plate). This is a description of two collections of Hepaticæ: the one, made by F. A. Moller, from the Island of St. Thomas, consists of thirty-four species, of which twenty are new; the other, by W. Mönkemeyer, about the mouth of the Niger, consists of sixteen species, of which eight are new.—The Hepaticæ of the Peninsula of Alaska, prepared by F. Stephani, comprise four new species, three of which are figured on plate iii. The fourth (*Frullania chilcootiensis*) is extremely small, only a few millimetres in length, and is found hidden in the roughnesses in the bark of the birch.—Comparative anatomy of the leaf of the family Olacineæ, by E. Edelhoff. This is a laborious investigation of minute details of the anatomy of the leaf, the outcome of which is apparently no new view as to the grouping of the members of the family, but rather the recognition of microscopic diagnostic characters.—Dr. Gürich, on the botanical results of the expedition of Flegel to the Niger-Binué.—Note on a recently disclosed Pliocene flora in the neighbourhood of Frankfurt/a/M., by Dr. H. Th. Geyler.—Abstracts of papers published elsewhere.

Nuovo Giornale Botanico Italiano, January 1887.—Signor A. Piccone continues his observations on the part played by phytophagous fishes in the dissemination of Algæ. The fish which appears to be by far the most effective in this direction in *Box Salpa*, L.—Dr. F. Tassi contributes an elaborate paper on anæsthesia and poisoning in plants. Among the general conclusions at which the author has arrived, the more important are that there exists in certain plants a property analogous to that which in animals is variously denominated irritability, contractility, excitability, &c., but that this property is located in no special organ, but originates in the protoplasm. Some substances which produce anæsthetic or poisonous effects in animals are in no way injurious to plants.

Rendiconti della R. Accademia dei Lincei, December 1886.—Researches on the nature of malaria, carried out by Dr. Bernardo Schiavuzzi in Pola, Istria. The results of these experiments show the constant presence of a Bacillus, morphologically identical with that already described by Klebs and Tommasi-Crudeli, in the malarious districts of Pola, and its absence from the healthy localities. This Bacillus, artificially cultivated and inoculated on rabbits, develops fevers showing all the characteristics of swamp-fever, while in the infected animals the red corpuscles of the blood undergo the same alterations as Marchiafava and Celli have shown to be characteristic of malarious infection. These alterations, however, are attributed by Dr. Schiavuzzi, not to the presence of a parasitic animal which has never yet been detected either in the air or in the soil of the infected districts, but to a deterioration of the blood-corpuscles directly or indirectly caused by the action of a pathological ferment of quite a different nature. He accordingly concludes that the *Bacillus malariæ* described by Klebs and Tommasi-Crudeli in 1879 is the true cause of marsh-fever.—On the objective spectroscope, by L. Respighi. The author claims the honour of having first introduced and applied to stellar spectroscopy the improved form of this instrument, as now generally used by spectroscopists. Although the important modification made by him is commonly attributed to Secchi, he shows conclusively that it had been adopted and successfully employed by him fully nine months before its application by Secchi in November 1869. An account of his first experiments with the perfected instrument appeared in the Atti of the Academy for May 20, 1869. The modification in question consists in replacing the large prism of Fraunhofer's instrument by one with a small refrangent angle, by means of which may be obtained perfectly distinct and well-defined spectra of the smaller stars.

Rendiconti del Reale Istituto Lombardo, January 13.—Annual Report on the progress of the mathematical and natural sciences, presented by the Secretary, S. Ferrini. In this general survey of work done by members of the Istituto, special reference was made to E. G. Cantoni's memoir on the phenomenon of dew, showing that Aitken's observations have been confirmed by the results obtained in Italy by Fusinieri, Melloni, and Cantoni himself, in opposition to the generally admitted hypothesis of Wells; to C. Poloni's experimental researches on the permanent magnetism of steel at various temperatures, formulating the law of variations caused by changes of temperature, and on his new method for measuring the absolute thermic conductivity of metallic wires; and to Giacomo Cattaneo's studies on the formation of gastric and intestinal glands in the embryo of *Salmo salar*.

Rivista Scientifico-Industriale, January 15.—Electricity developed with the formation of fogs and clouds, by Prof. Luigi Palmieri. Some electric phenomena recently observed at the meteorological stations of Naples and Vesuvius are appealed to in confirmation of the author's view that strong electric tensions in clear skies constantly indicate the near approach of clouds fogs, and even rain. Hence the strong tensions of atmospheric electricity so frequently signalled from the New York Observatory some days before the arrival of storms and wet weather on the west coast of Europe. During thirty-six years of constant study, the author has recorded thousands of similar observations, which have been overlooked by physicists dazzled by theories opposed to the natural conditions.—Further remarks on the question whether electricity is developed during the condensation of aqueous vapour, by Prof. Costantino Rovelli. In reply to the statements of Prof. Magrini, the author points out that, although his own experiments may have their weak side, the prolonged and repeated observations of Prof. Palmieri cannot be refuted by merely negative proofs.

SOCIETIES AND ACADEMIES

London

Physical Society, February 12.—Annual General Meeting.—Prof. B. Stewart, F.R.S., President, in the chair.—In opening the proceedings the President regretted that in their Report the Council have to record the loss of one who took a prominent part in the proceedings of the Society, the late Dr. Guthrie. It was, however, satisfactory to learn that the appeal of the Guthrie Memorial Committee, under the presidency of Prof. Huxley, had been generously responded to. The Council also learn with regret from Dr. E. Atkinson that owing to pressure of work he is unable to retain the office of Treasurer to the Society, and desire to express their thanks to him for his past services. Prof. Rücker has consented to be nominated for the office thus rendered vacant, and the Council believe that by his election the connection between the Society and the Normal School of Science (which is so desirable) will be maintained.—The Report of the Council for the year 1886 was read and received, and the following gentlemen were elected Members of the Council for the present year:—President: Dr. Balfour Stewart, F.R.S.; Vice-Presidents: Dr. E. Atkinson, Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, F.R.S., Prof. H. McLeod, F.R.S.; Secretaries: Prof. A. W. Reinold, F.R.S., Walter Baily; Treasurer: Prof. A. W. Rücker, F.R.S.; Demonstrator: C. V. Boys; other Members of Council: R. H. M. Bosanquet, W. H. Coffin, Conrad W. Cooke, Prof. G. Forbes, Prof. F. Fuller, Prof. J. Perry, F.R.S., W. N. Shaw, Prof. S. P. Thompson, C. M. Whipple, C. R. Alder Wright, F R.S.—The President proposed the following resolution: "That at the end of Clause 11 of the By-laws, which says, 'Every candidate for admission into the Society shall be recommended by not less than three members, to two of whom he must be personally known,' there be added, 'When a candidate living abroad is a member of a recognised scientific Society, such membership may, subject to the approval of the Council, be held equivalent to the personal knowledge aforesaid.'" The resolution was carried, subject to confirmation by a special general meeting to be held on February 26.—A vote of thanks, proposed by Prof. Ayrton and seconded by Prof. McLeod, to the Lords of the Committee of Council on Education, for the use of the rooms and apparatus of the Normal School of Science, was passed unanimously.—The Hon. R. Abercromby proposed a vote of thanks to the officers of the past year for their gratuitous services, which was seconded by Prof. Pickering.—Sir Philip Magnus proposed a vote of thanks to the auditors, Colonel Festing and Prof. Fuller, which was seconded by Mr. Lecky, and passed unanimously.—Mr. J. Brown was elected a Member of the Society.—The following communication was then read:—Note on the tenacity of spun glass, by E. Gibson and R. E. Gregory. The authors have experimented on the tenacity of glass rods and fibres made from the same piece of glass. The fibres varied from 1/25 to 1/50 mm. and the rods from about $\frac{1}{2}$ to 1 mm. in diameter. They find the tenacity per square centimetre of rods increases as the diameter decreases, as in ordinary wires, whereas with fibres this is not shown. Experiments were shown illustrating the method of working, and the highest tenacity recorded was for a fibre of ·0340 mm. diameter, which gave 466×10^7 dynes per square centimetre, a value about half as great as that for steel wires. The authors refer to Quincke's suggestion that the increased tenacity of small wires is due to surface-tension, and may be represented by $W = Ad + Bd^2$, where W is the breaking weight and d the diameter, but their own results with glass do not agree with this formula. Sir Philip Magnus asked if the diameters were measured at the point of rupture, if the elongation was determined, and whether the authors were able to suggest any other formula which would express their results. Mr. C. V. Boys remarked that the tenacity being so much affected by accidental circumstances, such as rate of cooling, no such formula could be expected. Prof. Rücker, referring to Quincke's experiments, said that the surface-tensions of metals calculated from them appear improbable. After some further remarks by the President, Prof. Ayrton, Mr. C. V. Boys, Prof. McLeod, and Mr. Gregory, the proceedings terminated.

Royal Meteorological Society, February 16.—Mr. W. Ellis, President, in the chair.—The adjourned discussion on the Hon. R. Abercromby's paper on the identity of cloud forms all over the world, and on the general principles by which their indications must be read, was resumed; and the following papers were read:—Remarks concerning the nomenclature of clouds for ordinary use, by Prof. H. H. Hildebrandsson; and Suggestions for an international nomenclature of clouds, by by the Hon. R. Abercromby. Both Prof. Hildebrandsson and Mr. Abercromby have paid great attention to the question of the forms of clouds, and having recently conferred together, they have agreed to recommend for international use the following ten principal varieties, viz.:—High-level clouds: cirrus, cirro-stratus, cirro-cumulus; middle-level: strato-cirrus, cumulo-cirrus; and low-level: cumulus, stratus, strato-cumulus, nimbus, cumulo-nimbus.—The influence of weather on the proportion of carbonic acid in the air of plains and mountains, by Dr. W. Marcet, F.R.S., and M. A. Landriset. The authors give an account of some experiments which they have made on the proportion of carbonic acid in the air at Geneva and on the summit of the "Dole," the highest point of the Jura chain, the difference in altitude being 4193 feet. The results of these experiments show: (1) that in fine clear weather on a mountain chain of moderate Alpine altitude, and in the adjoining valley or plain, the atmosphere holds the same mean proportion of carbonic acid at both places; and (2) that when the summit of a mountain chain is in a fog, a circumstance which frequently happens in an Alpine district, the air in the fog contains a smaller proportion of carbonic acid than it would hold in fine clear weather.—The Secretary, Dr. Tripe, read a letter received from Sir F. Abel, Organising Secretary to the proposed Imperial Institute, inviting the Society to draw the attention of the Fellows to the undertaking, with the view of their contributing towards it. The President stated that copies of the letter and of the accompanying paper, explanatory of the scheme, would be forwarded to each Fellow.

Mathematical Society, February 10.—Sir James Cockle, F.R.S., President, in the chair.—The following communications were made:—On the equation of Riccati, by the President (Prof. Hart, Vice-President, taking the chair).—The orthocentroidal circle (*i.e.* the circle whose diameter is the join of the orthocentre and centroid), by R. Tucker.—On polygons inscribed in a quadric and circumscribed about two confocal quadrics, by R. A. Roberts.—On the binomial equation $x^p - 1 = 0$; quinquisection, by Prof. Tanner.—Symmetrical determinant-formulæ in elliptic functions, by L. J. Rogers.—Notes on curves, by H. M. Taylor.—Some generalisations of differential formulæ connected with the change of the independent variable in a differential expression, with application to a new class of reciprocants, by C. Leudesdorf.

Geological Society, February 9.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—Evidence of glacial action in the Carboniferous and Hawkesbury series, New South Wales, by T. W. Edgworth David.—The terraces of Rotomahana, New Zealand, by Josiah Martin.—The eruption of Mount Tarawera, by Capt. F. W. Hutton. The paper began with a description of the country in which the eruption took place. From Tongariro to White Island, in the Bay of Plenty, a distance of 130 miles, there extends a belt, 20 or 30 miles wide, abounding in solfataras, geysers, hot springs, &c., and composed of volcanic rocks, chiefly rhyolite, with some augite-andesite. About the middle of this belt lie the mountain and lake of Tarawera, and two or three miles further south Lake Rotomahana, the spot where the famous Pink and White Terraces existed. Before the recent eruption there were no craters on Mount Tarawera, the form of which was a ridge, apparently due to denudation. Having described the eruption, Capt. Hutton briefly noticed the results of the eruption in the form of fissures on Mount Tarawera, the change of Rotomahana from a lake to a crater of larger dimensions, with precipitous walls, the formation of a new lake between this crater and Tarawera, and the formation of a number of small craters about Okaro. The materials ejected were composed of augite-andesite, and rhyolites, both compact and vesicular. The mineral structure and distribution over the surrounding country of various forms of pumice, scoria, and ash were described, and it was shown that there was a difference in the substances ejected from the mountain craters of Tarawera and those from the craters in the plain at Rotomahana and Okaro, the former comprising pumice and scoria, which were not thrown out from the latter, and but little steam issuing from the higher craters when compared with the enormous volumes emitted from the lower vents. The eruption was ascribed to the reheating of old lava-streams saturated with water. This reheating was apparently not due to crushing—for, had it been so, the preceding earthquakes would have been more violent—but probably to molten rock coming up from below and heating the rocks near the surface. The eruptions from Rotomahana and Okaro were purely hydrothermal.

Chemical Society, February 3.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read :—The absorption of gases by carbon, by Charles J. Baker.—An explanation of the laws which govern substitution in the case of benzenoid compounds, by Henry E. Armstrong. Certain mono-derivatives of benzene, especially those containing a hydrocarbon radicle, one of the halogens, hydroxyl or amidogen, yield a mixture of the para- and ortho-di-derivatives in proportions which vary both according to the nature of the compound dealt with and of the reagent, and the conditions under which the change is effected ; and if produced at all, the meta-derivative is formed in but a small proportion. If, however, the radicle present in the mono-derivative be—

$$NO_2, COH, CO_2H, SO_3H,$$

the meta-di-derivative appears invariably to be the chief product. Hitherto no explanation of this difference in the behaviour of the two series of mono-derivatives has even been suggested. In seeking to arrive at an explanation it is necessary to form a clear conception of the manner in which "substitution" is effected. The author is of opinion that in the first instance an additive compound is formed ; and he points out that Kekulé has long since insisted in the plainest terms on this interpretation of those cases of change which are commonly spoken of as "double decompositions." He is inclined to believe that the tendency of negative to attract and combine with negative elements—to which he has of late frequently directed attention—is the effective cause ; and that the additive compound is formed from those mono-derivatives which obey the "para-ortho law" by the fixation of the reacting molecule upon the carbon-atom which carries the radicle ; separation of water or halogen hydride ensuing thereon, the radicle of the reacting molecule assumes the place either of an ortho- or of a para-hydrogen atom. It is easy to understand the formation of the ortho-di-derivative, as the hydrogen-atom displaced is associated with a carbon-atom contiguous to that to which the reacting molecule attaches itself. The formation of the para-compound is attributed by the author to the tendency towards symmetry, so frequently evidenced in cases of isomeric change and in other ways by benzenoid compounds ; and not to the existence of any direct connection between carbon-atoms relatively in the para-position. The formation of meta-derivatives is believed by the author to result from the addition of the reacting molecule, not to the carbon-atom of the benzene-ring, but *to the radicle* which in the mono-derivative is attached to one of the carbon-atoms of the ring ; he is, however, of opinion that in order to explain why the additive compound thus constituted yields a meta-di-derivative, it will be necessary to obtain further information regarding the "dynamics" of such changes.—Some derivatives of tetramethylene, by G. H. Calman and Dr. W. H. Perkin, Jun.—Derivatives of pentamethylene, by Dr. W. H. Perkin, Jun.—The decomposition of potassium chlorate and perchlorate by heat, by Dr. Percy F. Frankland and John Dingwall.—The action of chlorine on methyl thiocyanate, by Dr. J. William James.

PARIS

Academy of Sciences, February 14.—M. Gosselin, President, in the chair.—On waterspouts and M. Ch. Weyher's recent experiments, by M. Faye. While fully appreciating M. Weyher's novel and interesting essays, the author makes certain reservations, especially as regards the term *trombe marine* ("waterspout") applied by him to one of the results. This, he submits, was not a true waterspout, but only a rotatory movement of a volume of air without any defined limits, and with aspiration towards the axis of the ventilator. But a true waterspout is characterised by a cylindro-conical funnel sharply outlined, descending from the clouds to the ground or to the surface of the sea, without exercising on it any perceptible aspiration.—Note on MM. Paul and Prosper Henry's photograph of the nebula No. 1180 of Herschel's general catalogue, by M. Mouchez. During their photographic operations on Orion on January 27, MM. Henry obtained an image of a nebula of 3′ to 4′ diameter with stars of the 17th magnitude, invisible to the observer with the equatorial of the East Tower. This nebula, which has also since been photographed by Roberts in England, has now been identified with that discovered at the Cape by Herschel, and by him indicated with the number 1180 in his catalogue.—Reply to M. Houzeau's recent note on a method to determine the constant of aberration, by M. Lœwy. It is shown that M. Houzeau's method of determining the constant from the differences in right ascension or in declination as measured at dfferent epochs, is liable to the most serious errors. In virtue of the diurnal movement, the two images are displaced in the field of the telescope at different rates of velocity and in any direction, their relative position changes from instant to instant, and under the given conditions cannot be accurately defined.—On a sandstone of organic origin discovered in the coal-fields of the Loire basin, by MM. Favarcq and Grand'Eury. Notwithstanding their chemical composition these remarkable deposits belong evidently to fresh-water organisms, which cannot at present be further identified. They abound especially in the Rive-de-Gier and Saint-Etienne districts.—The inauguration of railways in France : its true date, by M. Léon Aucoc. It is pointed out that the proposed celebration in 1887 of the fiftieth anniversary of this event rests on an historical error. The first line actually completed was that between Saint-Etienne and Andrezieux, 23 kilometres long, opened on October 1, 1828 ; that is, nine years before the assumed date 1837.—Remarks on the palæontological researches made in the Lower Tertiary deposits in the neighbourhood of Rheims, by M. V. Lemoine. The author gives the general results of his investigations carried on uninterruptedly for the last fifteen years, and constituting the Rheims district one of the points where the beginning of Tertiary life may be best studied in Europe. The fossil vertebrates alone studied by him now number 94, of which not more than 8 or 10 were previously known. Amongst them are 40 mammals belonging to 23 different genera, of which 8 only had hitherto been observed in later Tertiary beds.—On the mode of formation of the striated Bilobites, by M. Ed. Bureau. The author has obtained plaster casts of most of these Bilobites, from a careful study of which he concludes that they must represent imprints of animals on the sands of shallow Silurian waters.—Combined action of belladonna and opium in a case of acute diabetes, by M. Villemin. After the usual remedies had failed, this treatment was lately tried in an extreme case of diabetes at the Val-de-Grâce Hospital, with complete success.—Determination of the position of the shaft corresponding to a given position of the piston in a steam-engine, by M. H. Léauté. Two remarkably simple graphic constructions designed in 1869 by M. Marcel Deprez are described, by means of which the position of the shaft for each position of the piston may be determined with sufficient accuracy, when the length-ratio of connecting-rod and shaft is greater than 3.—On the application of photography to M. Lœwy's new methods of determining the elements of refraction and aberration, by M. Ch. Trépied. An inquiry is here made into the conditions and means by which M. Lœwy's new and effective method of photographic registration might be utilised in determining the elements of astronomic refraction.—Observations of Barnard's and Brooks's comets made with the 0·38 m. equatorial, Bordeaux Observatory, by MM. G. Rayet and Courty.—On surfaces where the difference of the chief radii of curvature is constant at each point, by M. R. Lipschitz.—On a certain class of recurrent sequences, by M. Maurice d'Ocagne.—On the specific heats of liquids, by M. Marcellin Langlois. By the process here described the author determines the specific heats of water, sulphuret of carbon, chloroform, chloride of carbon, ether, alcohol, and acetone. — Researches on the specific inducting power of liquids, by M. Negreano. The author determines the dielectric constants of a series of homologous and liquid carburets of hydrogen for the purpose of comparing the dielectric constants with the molecular weights and densities. He also determines the index of refraction of these different liquids with a view to the verification of Maxwell's law.—On the variable period of the current in an electro-magnetic system, by M. R. Arnoux.—Physical researches on the isomery of position, by M. Alb. Colson. Having succeeded in transforming orthoxylene and metaxylene into alcohols, glycols, ethers, &c., isomerous with the known compounds of paraxylene, the author here inquires whether bodies so closely related in their chemical properties may not also be connected by some physical relations. The best results have been obtained by the calorimetric process.—Action of the oxide of mercury on some dissolved chlorides, by M. G. André. In this preliminary paper the author deals with the chlorides of barium, calcium, strontium, and magnesium.—On the action of hydrochloric acid on the solubility of the chlorides, by M. R. Engel. His further studies enable the author to generalise the law already announced by him in the *Comptes rendus* for March 1886.—A new process of analysing the carbonic acid emitted, and the oxygen inhaled, in the act of breathing, by MM. M. Hanriot and Ch. Richet. The differential method here described as applicable, with some modifications, to the analysis of various gaseous mixtures, constitutes a simple and rigorous method for the quantitative analysis of those of respiration.—The formic salts, by MM. Gréhant and Quinquaud. The authors here discuss the question as to what becomes of the formic salts introduced into the system, and find that the formiate of soda injected into the digestive organs or into the blood mostly passes unchanged into the urine.—On the properties of colchicine, by MM. A. Mairet and Combemale. Their experiments on dogs and cats satisfy the authors that this substance is an irritant poison which attacks all the organs, but especially the digestive tube and the region of the kidneys.—On the effects of the transfusion of blood into the head of decapitated animals and men, by M. J. V. Laborde. The author refers to his numerous experiments on this subject, which were overlooked in the paper recently presented to the Academy by MM. Hayem and Barrier.—On the comparative morphology of the brain in insects and crustaceans, by M. H. Viallanes.—The males of *Lecanium hesperiaum* and the question of parthenogenesis, by M. R. Moniez.—On the zoological researches carried out during the second scientific expedition of the *Hirondelle*, in 1886, by Prince Albert of Monaco.

BERLIN

Physical Society, January 7.—Prof. von Helmholtz in the chair.—Dr. R. von Helmholtz developed theoretically the formulæ expressing the relations subsisting between vapour-pressure, the melting-point, pressure, and volume, and enabling the vapour-pressures in the fluid and solid state, or the freezing-points and the change of the melting-point with that of the pressure, to be calculated.—Dr. Thiesen, while engaged in working experiments instituted by Schellbach respecting the resistance of air, had found an expression for the force of resistance in accordance with which a medium with less interior friction must necessarily offer a greater resistance than did a medium with more friction. This induced him to carry out experiments of his own with cylindrical rods regarding the resistance of air. On a hardened steel point a brass cylinder open at the bottom and bearing at its lower end externally two conjoined pieces, into which the steel rods 1 metre long and 1 English inch thick could be inserted horizontally and diametrically opposite to one another, was able to rotate. By means of a cord circulation, the cylinder was set rotating, and the abatement of speed consequent on the resistance of the air was noted by each half-revolution being marked electrically. These experiments yielded the same formula for the resistance as had been obtained from the earlier experiments. Another important result was that the method employed for the measurement of the resistance of air had maintained its validity remarkably well. In the discussion following this address, Prof. von Helmholtz took part. He called attention to the formation of whirling surfaces and whirls on the rotating bodies, a matter which in a high degree complicated the phenomenon.—Dr. Thiesen made a further communication respecting the determination of the national standard kilogramme. The cylinders of platinum-iridium, weighing rather more than 1 kilogramme, which were cast in London, were tested in respect of their density, and so often as fissures were detected they were re-cast. They were thereafter polished and again tested. Forty-two such standards were next compared with one another, and their uniformity and non-liability to be affected by transport having been ascertained, they had then to be compared with the kilogramme of the Archives, and after examination by the International Commission were despatched to the different Governments.

BOOKS AND PAMPHLETS RECEIVED

Histoire des Sciences Mathématiques et Physiques, vol. x.: M. Marie (Gauthier-Villars, Paris).—Proceedings of the Linnean Society of New South Wales, 2nd series, vol. i. part 3 (Cunninghame, Sydney).—Nomenclature of Color for Naturalists: R. Ridgway (Little, Brown, and Co.).—Bulletin of the Philosophical Society of Washington, vol. ix. (Washington).—Hourly Readings, 1884, part 2, April to June (Eyre and Spottiswoode).—The Origin of the Fittest: E. D. Cope (Macmillan).—Geographical and Geological Distribution of Animals: A. Heilprin (K. Paul).—Hints for the Solution of Problems of Solid Geometry: P. Frost (Macmillan).—Levelling and its General Application: T. Holloway (Spon).—Observations Météorologiques de Godthaab: A. F. W. Paulsen (Gad, Copenhague).—*Challenger* Expedition Reports—Zoology, vol. xvii.; Botany, vol. ii.—Philosophische Studien, Vierter Band, 1 Heft (Engelmann, Leipzig).—Encyklopædie der Naturwissenschaften, Erste Abth., 50 Lief.; Zweite Abth. 39, 40, 41 Lief. (Trewendt, Breslau).—City Government of Boston, Mass.: J. M. Bugbee (Baltimore).—Annual Address to the Asiatic Society, Calcutta, February 2, 1887: E. T. Atkinson.—Halifax, Annual Report of Public Library Committee, 1885-86.—Beiblätter zu den Annalen der Physik und Chemie, Band x. (Barth, Leipzig).

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