THURSDAY, SEPTEMBER 17, 1874

THE EDUCATION OF WOMEN

NONE of the subjects discussed at the recent meeting of the British Association at Belfast were of greater practical importance than the one introduced to the notice of the Economic Section by Mrs. Grey in her paper on the Science of Education, and supplemented by the address afterwards delivered by her at a meeting held under the auspices of the National Union for Improving the Education of Women of all Classes. So much nonsense is talked and written on the theme of the higher education of women, the utterances even of some of those who are looked on as authorities on the question are too often so doctrinaire and unpractical on one side or the other, that it is a relief to read the well-considered and thoughtful reflections of one who has bestowed much labour and serious thought upon it, and who has given evidence that she is wedded to no preconceived views. The crowded attendance at the Section when Mrs. Grey's paper and the two which followed it—also by ladies—were read, and the lengthened and animated discussion to which they gave rise, sufficiently evince the wide interest felt in the subject by those who attended the meetings of the Association.

The branch which specially concerns us is the extent to which instruction in some or all of the various branches of science should enter into the liberal education of women; and this again is but a phase of the more general question as to the mode in which, if at all, the education of girls should differ from that of boys. We may set aside on the present occasion as a subject of too great importance to be discussed in a general article like this, the much-vexed question of the Medical Education of Women. With regard to the difference which has been established by general custom or prejudice between the ordinary curriculum of the studies of boys and girls, Miss Davies has pointed out with great force, in one of her Essays on the Higher Education of Women, what appear at first sight some glaring inconsistencies and absurdities. To boys who are destined for a mercantile life or a public career, an intimate acquaintance with French and German is now almost indispensable; Latin and Greek are therefore almost universally taught in boys' schools, while the modern languages are considered an essential part of the course of study of a girl, to whom they will be of much less service. A fair knowledge of the elements of physics and chemistry would be of immense advantage to a woman in the management of a household; but these are subjects considered by many to be decidedly unfeminine. Music is the most inexhaustible and harmless recreation for the mind overtasked with the burden of daily cares; but music hardly comes within the scope of a boy's education, at least in this country; while it is almost compulsory on girls, whether they have the talent for it or not, and who have at all events abundant other occupation, such as needle-work, for their leisure moments. The earliest years of a child's life are almost entirely regulated, for good or for evil, by the mother and her female dependents; but any knowledge of human physiology or hygiene has been till recently almost forbidden to the girl on the score of delicacy. May we not sum up by saying that few men have the leisure, after they arrive at manhood, for pursuing the studies of their youth; while an enormous number of women of the upper and middle classes would be most thankful for a rational substitute for the purposeless vacuity in which they are at present forced to spend a large portion of their time? And yet in the face of this it is still the orthodox creed that the education which any English gentleman gets or can get at a public school or University is too broad or too deep for the mass of women of the same class.

An almost ludicrous instance of the difficulty which is experienced practically in the attempt to frame a curriculum of studies which shall be specially adapted for girls, was brought out in the recent debate in the Convocation of the University of London on the desirableness of admitting women to degrees. When the existing General Examination for women was instituted, a Committee of the Senate was appointed to draw up a scheme which should meet all the requirements of the case. After long deliberation, the extent to which it was found possible to deviate from the ordinatry Matriculation examination was this: Greek was made optional; and girls were allowed to take Botany if they wished instead of Chemistry, and Italian if they preferred it instead of German; they were also exempted from all the books of Euclid except the first, if they took Geography instead! The first of these indulgences is now extended to boys; and the other differences are so trivial that we are glad to see that another Committee of the Senate has already recommended that the examination be altogether assimilated to that for Matriculation. When this is done, it may possibly occur to the Senate that there will be no object in keeping up a distinction of name between the two; and how will it then be possible to refuse to women examinations which shall be equivalent to those that admit men to degrees, at least in the Faculties of Arts, Science, and Laws? We do not propose here to discuss the expediency of nominally permitting women to take degrees in our universities; but there is one aspect of the question which has hardly been sufficiently considered by those who oppose the innovation. A university degree is the acknowledged hall-mark of a certain standard of education for men who make teaching their profession. A very large number of women are equally dependent on teaching as a means of livelihood; notwithstanding the many additional facilities given them of late years for acquiring knowledge, they have at present no equivalent test of their qualifications; and as long as this is the case the really competent governess or schoolmistress will always be subject to unequal competition from her incompetent sisters, and the rising generation of both boys and girls will be the sufferers.

The vision that frightens many from looking with candid and impartial mind at the problem of the higher education of women is the fear that the educated woman will be lifted out of what we are pleased to term her sphere, and rendered unfit for what man considers to be her duties. But the admirers of the uneducated woman may take comfort in the assurance given them by Prof. Fawcett at the Brighton meeting of the British Association, that whatever facilities are offered for improving their minds, there will still be left for many years an ample supply of those who prefer to remain ignorant and uncultured to satisfy all demands. In the noble address delivered by Prof. Huxley at Belfast, he insisted, with all the force of his calm eloquence, on the folly of making a bugbear of logical consequences; and in no science is there more need for this exhortation than in that of education. Mrs. Grey well put it that no education is worthy of the name that does not at least aim at a right training of the three departments of the mind—the reasoning faculties to determine the right from the wrong, the emotional to follow the right when found, and the imaginative to conceive the perfect ideal of all goodness. In determining a course of education, whether for boys or girls, when we have once satisfied ourselves that our principles are sound, let us unhesitatingly follow them out, letting the possible consequences take care of themselves; and we may feel sure that the conclusions to which we shall be led will stand the test of experience.

The point which we think should be most prominently brought forward by the advocates of a reform in female education is not so much the desirableness of turning its future current in any one direction, as the necessity for removing all trammels and barriers raised by man's ignorance or prejudice. On this ground we sympathise most heartily in all the efforts now being made to widen the basis of the education of women, whether in the way of special colleges, university examinations, or courses of lectures involving severe study. Let us first of all—divesting ourselves of all preconceived theories on the subject, whether social, metaphysical, or physiological—give free scope to the faculties of woman before we begin to dogmatise on the extent to which these faculties will bear cultivation. Natural Selection will point out the occupations in which the female mind will excel; and the Survival of the Fittest will determine the professions in which woman can successfully compete with man. And every one who believes that faculties were originally endowed or gradually evolved for the purpose of being used, and powers for the sake of being exercised, must rejoice at every fresh extension of the field in which they may be employed.

DE BOISBAUDRAN ON SPECTRES LUMINEUX

Spectres Prismatiques et en Longueurs d'Ondes destinés aux Recherches de Chimie Minérale. Par M. Lecoq de Boisbaudran, avec Atlas des Spectres. (Paris: Gauthier-Villars, 1874).

THE spectrum maps of Kirchhoff, Huggins, Angström, and Thalen are so complete that little has been left for later observers except the filling up of some details. Angström's discovery that the bright lines which form the spectrum of the electric spark are partly due to the air or other gaseous medium traversed by the spark, partly to the vapour of the metallic poles, formed an epoch in the history of spectrum analysis; and the publication of the fine map of the solar spectrum by Kirchhoff (founded on the great original work of Fraunhofer), in which the positions of a large number of the metallic lines are carefully laid down, gave a great impulse to the pursuit of this branch of physical science. For the discovery of the new metals, cæsium, rubidium, thallium, and indium, we are indebted to spectroscopic analysis. In a paper communicated to the Royal Society in 1863, Mr. Huggins gave a valuable map of the bright lines of the metals, as seen through a system of prisms adjusted for a minimum deviation of the line *D* of Fraunhofer. This was followed by the works of Thalen and Mascart, in which the positions of the metal lines are given in wave-lengths. The results obtained by Thalen are incorporated in the great work of Angström on the solar spectrum.

To observe the metal lines, the method usually employed is to pass the spark from a Ruhmkorff's machine, having a condenser connected with the fine wire, between poles of different metals. The air lines which come into view at the same time are easily distinguished by well-known characters from the metal lines, and were used by Mr. Huggins to fix the positions of the latter. In some cases the metal lines were obtained by drawing sparks from solutions of the chlorides.

In the work of M. Lecoq de Boisbaudran, two methods are chiefly followed for obtaining the spectra of the elements and of certain compound bodies. The first is the ordinary method of heating the body in the flame of a Bunsen burner; the second is to pass short electrical sparks from a Ruhmkorff's coil, *without condenser*, between a solution of the chloride of the metal and a fine platinum wire suspended above the solution. In the latter case the following is the method of experimenting usually employed by him:—The metallic solution is contained in a short glass tube, into the lower end of which a platinum wire is hermetically sealed. Another wire of platinum, or, still better, of iridium, attached to an insulating support, is adjusted at a distance of two or three millimetres from the surface of the liquid. An essential condition to the success of the experiment is to make the free wire positive, and the liquid negative. If this condition is reversed, the spectrum of the solution seldom appears, but is replaced by the ordinary air spectrum. In some cases, as with the alkaline salts, a fine spectrum is obtained by passing sparks between a fused bead of the salt and a platinum wire heated to redness in a Bunsen or spirit flame. According to M. Lecoq de Boisbaudran, the spectrum produced in this way is not only more brilliant, but is richer in metallic lines than that of the solution. The method of taking sparks in air between metallic poles has been employed in the work before us only in the cases of aluminium and lead. The spectroscope employed was formed of a single prism of heavy glass, with a collimator, and telescope moveable on a graduated arc. An illuminated scale, projected from the anterior surface of the prism, was seen above the spectrum, and its indications were reduced to wave-lengths by comparison with the wave-lengths of certain solar and metallic lines, as determined by Fraunhofer, Mascart, Angström, and Thalen.

In a series of twenty-eight finely-executed engravings, M. Lecoq de Boisbaudran has given delineations of the spectra of a large number of bodies referred to the arbitrary scale of his spectroscope, and also in wave-lengths. Except in a few cases, he has not attempted to represent the feebly illuminated ground or continuous spectrum which in many instances extends over nearly the whole field of view. But the characters of the bright lines and bands are carefully represented, and a full description of them is given in the body of the work. The whole is designed to facilitate the application of spectrum analysis to mineral chemistry; and although some of the details may hereafter require correction, the work is well executed, and cannot fail to be of great value to the scientific and practical chemist. The frequent reproduction of the comparatively simple spectra of the metals obtained at the low temperature of the gas flame in elementary works of chemistry, unaccompanied by sufficient explanation, has tended to give rise to partial and even incorrect conceptions of the grandeur and extent of this subject. How many persons believe that the spectrum of sodium consists solely of a pair of fine lines corresponding to the double line *D* of the solar spectrum? How few know that at the high temperature of the electrical spark it exhibits three other pairs of well-defined lines, one in the orange, another in the yellow, and another in the green, together with a nebulous band on the confines of the blue? (Huggins). All these lines may easily be seen by passing the electrical spark in a non-luminous flame between a fused bead of sulphate or chloride of sodium and a platinum wire, together with a few other feeble lines, especially in the violet (Lecoq de Boisbaudran). The vivid line in the red, with its faint companion in the orange, which forms the ordinary spectrum of the compounds of lithium in the gas flame, gives place to a very different spectrum, when sparks are drawn from a solution of the lithium salts. The red ray still continues vivid, but it is surpassed in intensity by the orange, which is now the most characteristic of the lithium rays, while two new rays or lines come into view (λ 497·0, 460·4). With a solution either of the ferrous or ferric chloride, the electrical spark gives the numerous lines with great sharpness and accuracy of detail, which constitute the spectrum of metallic iron.

M. Lecoq de Boisbaudran gives a delineation of what he considers to be the spectrum of oxide of barium, as it appears after a prolonged heating of the chloride in the gas flame, and also of the spectra proper of the chloride, bromide, and iodide of barium, as obtained by heating those salts in the gas flame charged with hydrochloric acid, bromine, and iodine vapours respectively. These spectra are all different. Thus, in the case of the chloride, only slight traces of the lines and bands due to the oxide are seen, while six new lines appear which are very intense (A. Mitscherlich). On the interesting subject of the bright lines which compose the spectrum of the earth erbia and its phosphate, the following observations are made in the work before us:—"According to Bunsen and Bahr, the addition of a little phosphoric acid to solid erbia gives to that earth a greater emissive power and renders the lines sharper, without modifying their number or position. On repeating this experiment, I find that erbia alone and erbia to which phosphoric acid has been added give very different spectra. On comparing the spectra, the red is more developed in the light of the phosphate, whilst the green and the violet-blue are more vivid in that of the oxide."

The limits of this notice do not permit the discussion of questions of great interest in spectrum analysis, many of which promise soon to be fully resolved. The observation of Roscoe and Upton, that the broad bands characteristic of certain metallic compounds at the low temperature of the gas flame disappear at the higher temperature of the electrical discharge, and the view they have set forth, that in the former case the spectrum is that of the compound, in the latter case that of the metal, have received confirmation from later researches. Lockyer, in his valuable contributions to spectrum analysis, has shown that what he designates the shortest lines disappear first on reducing the pressure, and that the difference between the spectrum of the chloride and the spectrum of the metal is that under the same spark condition all the short lines are obliterated in the former case. The same investigator has observed that metallic elements of low specific gravity, such as sodium, calcium, magnesium, and aluminium widen their lines by increase of vapour density, while metallic elements of high specific gravity, such as iron, cobalt, and nickel, increase under the same condition the number of their lines.

THOMAS ANDREWS

OUR BOOK SHELF

Comets and the New Comet of 1874. By the Author of "Astronomy Simplified for General Reading." (London: William Tegg and Co., 1874.)

THIS book purposes to be "a complete popular account of all that is known of these wonderful bodies which are so great a perplexity to science:" but the work consists of only 56 pages, and it is needless to say that even a popular account of these bodies to be complete must extend over a much larger space. We think that a work on any subject in science, to be popular, that is written to be read by the public at large and not by persons who are conversant with the subject only, should not refer to explanations or theories that are not generally known, without a very intelligible explanation; theories of the action of observed phenomena should not be given without a very strong probability of their truth, or without a caution against their acceptance; and in dealing with a subject like the present one, when our knowledge is limited, and when there are so many different modes of explaining appearances, it behoves an author to use more than ordinary caution against the mention of anything that is not strictly in accordance with ascertained physical laws. On both these points the present book is at fault. As an instance, the author mentions M. Faye's theory of the repulsive power of the sun in virtue of its heat, and then urges objections to the theory without a word of explanation of it. Now to a person not conversant with the experiments on the repulsion of gases and solids by heat rays, the theory would seem absurd and contrary to experience; and so the author carries the day with the theory that the effect of solar heat upon the cometary matter is electrical in its action. Again, he says: "For example, the matter of comets is not possessed of concentric attraction even with reference to itself, neither is it possessed of chemical affinity for itself. This is fully established by the eccentric forms of comets and through conspicuous variations of shape and size.'" This is quite new to us. Again, after mentioning that Lexell's comet was entangled for about a month among the satellites of Jupiter, he says: "Is there another instance—a single analogy on record outside of cometary phenomena—of a body of dead matter under great velocity being actually barred and stopped in its path for four months, and then suddenly starting off again after being divested of its force for so long a period? What can the composition and resolution of forces do for us here? for here is the most wonderful problem ever submitted to their laws. What must be the amazing force of a body which, like an unspent cannon-ball impeded by a bank of earth, keeps spinning and grinding in its bed for four months, and then suddenly goes off with unabated velocity as if it were merely ricochetting from its point of interruption?"

Did the writer never hear that the motion of this comet was in strict accordance with the laws of gravitation, and Laplace used it for corrrecting the value of Jupiter's mass? In these cases, and in many others, the author has gone sadly astray. The accounts of the appearance of the different comets are good and clear and are well worth reading, but one or two drawings of comets would have improved matters considerably. There is a plate at the beginning of the book, of the earth in a comet's tail, which draws somewhat on the imagination. A want of soundness with reference to mechanical laws appears throughout the book, for we read of the two parts of Biela's Comet having less mass to be acted upon by solar attraction than they had before separation, so that the original orbit must have been altered; and we hear of a comet altering capriciously its centre of gravity with reference to solar attraction. The words orbit*u*al and phosphor*o*us occur frequently, we hope for the last time. The book is spoilt by the endeavour to explain the appearances of comets without regard to the most fundamental physical laws which have so far been found to be rigorously exact. G. M. S.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Pollen-grains in the Air

MR. HUBERT AIRY'S letter printed in your issue of Sept. 3 appears, to a great extent, to reconcile that gentleman's observations with my own. My set of drawings have been made entirely from pollen-grains in the *dry* state, and in this condition (in which of course it is wafted through the air) I find the pollen of plants fertilised by the wind, though belonging to the most widely dissociated natural orders, to be uniformly, as far as I have been able to observe, nearly or perfectly spherical, with no prominences or furrows visible on magnifying about 250. A very short immersion in glycerine would cause the protrusion of the intine through the weak spots of the extine, and would give to the grains of birch and hazel the spherically triangular appearance described by Mr. Airy, and represented in some of the plates by an old German writer. ALFRED W. BENNETT

Penmaenmawr, Sept. 9

Fossils in Trap

WHEN examining the great exposure of trap and associated Upper Silurian rocks at Cape Bon Ami, New Brunswick, I unexpectedly found fossils in the trap. I was at the time collecting agates and amygdals of calcite. One amygdal attracted my attention as singularly regular in shape. On detaching it from the rock and examining it with the magnifying glass, I found it to be a coral, *Favosites gothlandica*. The fossil is nearly circular. Its greatest diameter is $1\frac{7}{10}$ in., its smallest diameter $1\frac{5}{10}$ in., its greatest thickness is $\frac{1}{2}$ in. Notwithstanding the rubbing by exposure on the shore, many of the cells are quite distinct: the side attached to the trap is without cells. I found a second specimen of a similar coral in another part of the trap-rock. Of this the length is 1 in., the width $\frac{8}{10}$. The exposed part is a section having the structure perfect; it is slightly weathered. The fossil is indissolubly united with the trap, its sharp septa penetrating it: the trap of the specimen is very compact.

These fossils are derived from the associated strata of Niagara limestone: Wenlock limestone age.

The strata have been coral reefs: they are filled with corals, *Favosites* and *Cyathophylla*. I collected magnificent specimens of the former, also *Crinoid* joint, *Orthis* sp.? *Strophomena depressa*, *Atrypa reticularis*, *Rhynchonella* sp., *Athyris nitida*, *Orthoceras* sp.?

The fossils are easily detached from the strata.

I have no doubt that the notice of the occurrence of the fossils in trap will be new to many of your readers. In all my investigations I have not met with a similar occurrence. The first example proves that the trap was, at least, in a *plastic* state when the fossil dropped into it. The second proves that it was in a *fluid* state.

This is all very satisfactory to us, as proving that trap is a true *lava*, although the Wernerian might thereby infer that the trap was a sedimentary rock. The section of the coral in the trap is as perfect as sections of *Lithostrontion* in the Lower Carboniferous limestone of East River Picton in our museum collection.

By what process were these fossils preserved from destruction in the molten trap? D. HONEYMAN

Halifax, Nova Scotia, Aug. 27

[Our correspondent does not define in what sense he uses the vague word "trap." Fossils, both animal and vegetable, are of common occurrence in some kinds of "trap," *e.g.* in the different forms of tuff. We presume that the specimens he refers to were of true basalt, or some other form of crystalline, and once molten igneous rock. If so the fact is interesting, though possibly some of our readers may be able to adduce similar cases.—ED.]

Curious Rainbow

THREE or four days ago I observed a phenomenon which may possibly be interesting to some of your readers. I was standing on a hillside, about 200 ft. above the sea, and saw a rainbow of the ordinary description, very vivid and extending to the horizon at both ends of the arch; outside this was a secondary bow, also very distinct, and inside the primary bow was a series of coloured bands, to all appearance identical with the series in the primary bow from the green to the violet, so placed that the green of this third bow was next to the violet of the primary bow, and the violet of the third bow the innermost of all. There was no appearance of any superposition of colours, and the third bow was nearly as bright as the primary, and the interval between them was hardly appreciable. The whole series was concentric. I have not observed any notice, in works on the subject, of a phenomenon similar to this, or any hint that it might be expected according to the geometrical or physical theories of the rainbow, and therefore think the appearance may possibly be of rare occurrence. R. P. A. SWETTENHAM

Glen Caladh, Kyles of Bute, Sept. 5

Polarisation of the Aurora

IN answer to Mr. Procter's first question (vol. x. p. 355), I would refer him to NATURE, vol. vii., p. 201, where he will find an account of observations of the polarisation of the zodiacal light, and of the aurora, by Mr. Ranyard, who appears to have used a double image prism and Savart, during the great aurora of Feb. 4, 1872, and to have detected no polarisation. He refers also to some observations made upon the small aurora of Nov. 11, 1871, in which he could detect no polarisation. The only other account of observations that I have met with are contained in the report of Prof. Stephen Alexander on his expedition to Labrador, given in Appendix 21 of the United States Coast Survey Report for 1860, p. 30. He found strong polarisation with a Savart's polariscope, and, what is most remarkable, thought that the dark parts of the aurora gave the strongest polarisation. This was at the beginning of July. He was in latitude about 60°, and the observations appear to have been made near midnight. But he does not state whether there was twilight or traces of air polarisation at the time, nor does he give the plane of polarisation.

Cheltenham J. A. FLEMING

FRANCIS EDMUND ANSTIE, M.D., F.R.C.P.

ON Saturday, 12th inst., in his forty-first year, after an illness of only four days' duration, died Dr. F. E. Anstie, from the consequences of a dissection-wound inflicted while he was investigating the causes of a serious and somewhat mysterious disease which had for some time prevailed in a large school at Wandsworth, and had rapidly carried off several of the pupils. Thus he must be enrolled in the list of those who have fallen in the cause of scientific investigation.

Dr. Anstie was a student of King's College, and took his doctor's degree at the University of London in 1858, since which time he has devoted much of his leisure to the investigation of therapeutical and pathological problems. His work on "Stimulants and Narcotics," published in 1864, first brought him into notice as an upholder of the value of alcohol as a nutritive agent, in contradistinction to the opinion of M. Lallemand, that its action is simply stimulant. In conjunction with Dr. Burdon-Sanderson he was one of the first in this country to direct attention to the Sphygmograph of his friend Prof. Marey, of Paris. Sanitary reform was another subject to which Dr. Anstie paid much attention, and with great success. His article on "Neuralgia" in Reynolds' "System of Medicine," and his important work on the same subject, made him well known as a physician, as did his papers in the *Practitioner*, of which he was the editor.

Dr. Anstie was physician to Westminster Hospital, where he was also lecturer on Medicine. The new physiological laboratory of that institution, which is to be opened next month, owes much to his energy; and no one, more than himself, looked forward to the opportunities it will afford for original investigation. Dr. Anstie's loss will be felt by a large circle of friends, whom he had an unusual power in making and retaining, on account of the genuineness and force of his character.

HIEROGLYPHIC TABLETS AND SCULPTURE IN EASTER ISLAND

EARLY last spring mention was made in NATURE (vol. ix. p. 351) of some photographs of inscribed tablets from Easter Island, which the Academy of Sciences at San Francisco had shortly before received from Mr. Croft, of Papeeti, Tahiti.

Up to that time only three tablets were known for certain to have been discovered in the island. From information, however, which has recently been received, it appears that there are now no less than five tablets at the Roman Catholic Mission in Tahiti; and one, obtained last year by the mate of a vessel wrecked on the island, is said to have been taken to San Francisco. Two others are in the National Museum at Santiago de Chili;* and casts from these, made under Mr. E. Reed's directions, were sent to England and Germany in 1873. This, however, is not all. Natives who are in the employ of planters at Papeeti inform Mr. Croft that incised tablets were formerly very numerous in Easter Island, but many were destroyed in intestine wars. Some are said to have contained descriptions of land and boundaries; others, directions for planting and fishing; many were connected with religion and mythology; and, more important than all, a few "contained the ancient history of the island, and its kings or ruling chiefs:" these, it was feared, might all have been destroyed, not by the natives themselves, but by direction of Roman Catholic priests, who, as in America at the time of the Spanish conquest, persuaded their first converts to burn and destroy a large number of records without discrimination. It is known, however, that a few remain in possession of the islanders, who are said to attach the greatest possible value to them.

Should no others prove to be historical, it is almost certain that one, at least, of those at Santiago, of which we have the plaster casts, answers this description. The tablet alluded to is fully described in the *Journal of the Anthropological Institute*,† where plates will be found of the hieroglyphics.

Some of the older natives of Easter Island are said still to possess the art of engraving tablets, and to be able to interpret them. But whether this refers to the ancient signs, or only to those which Señor G. de la Rosa found were used by the chiefs a hundred years ago, is at present doubtful. Dr. Philippi, of the University of Santiago, on the authority of Père Einaud, one of the French missionaries, says that the natives do not attach any meaning to the signs. Probably expert wood-carvers like the Easter Islanders would from time to time have replaced decayed tablets and multiplied others. They may also, very possibly, know from the general appearance of the hieroglyphics what they refer to, and yet not understand individual signs.

Before showing that it may prove an easy task for anyone acquainted with the Pacific to interpret the signs, provided he has some knowledge of the traditions of the Easter Islanders, it will be necessary to mention the legend of their origin as ascertained by Commodore Powell and Señor Gana from the missionaries on the spot (in 1868 and 1870). It is briefly this: that their ancestors arrived in two boats many years ago, each boat being under the command of a chief; and there is a distinct tradition that they had been expelled from Oparo, or Rapa-iti, an island 1,600 miles to the west.

Now there is a drift-current from that direction, that carries wood and other waifs to the shores of Easter Island; so that it is physically possible for a canoe or other vessel to have arrived by its aid. It is worth mentioning that the current turns round Easter Island, and then goes northwards.

Oparo, also, bears silent witness to the truth of the story. Though little more than seven miles in length, several of its hills are capped with stone forts; and there are platforms and stone houses as in Easter Island, as well as a fortress or temple in five stages (like the ruin of Pollanarrua, in Ceylon). It need scarcely be added that there are traditions of fierce wars and feuds in the island.* Unfortunately, little more than this is known about its antiquities and legends.

Passing by, with the bare mention, several symbolic practices of the Easter Islanders—for example, the enormous trouble that was taken by them to crown the great statues with huge tiaras of red tufa; the erection of effigies of their chiefs on platforms of squared stone, the masonry of which, Cook said, was "equal to any in England;" the peculiar form of the huts, like inverted boats; their moon-shaped shields, used only in dances (some with faces carved on the cusps, like the eagles' heads on the Phrygian peltas); the bi-fronted staffs or batons, which were held in the hands of the chiefs; and tattoo marks like those in Burmah and India,—all of which may possibly, by and by, aid us in discovering the land from which the mysterious chiefs of Easter Island originally came,—passing by these, we will confine our attention to the symbols which appear more immediately to relate to the arrival of vessels from Oparo, and seem to establish the tradition on an historical basis.

Few who have visited the Cnidus Shed at the British Museum can have failed to notice the emblematic carving on the back of one of the statues from Easter Island, at present deposited there. It was found under cover in the range of stone houses called "Taura Renga," in the centre of a chamber lined with wall slabs, and partly excavated from the cliff. The bas-reliefs faced the entrance, a small square door, with stone posts and lintel, in a rubble wall about 5 ft. in thickness. On the back of the head of the statue there is a bird, over which is a solar crown; and on either side a rapa, or steering paddle, with a human face on the spade-like blade.† A third but very much smaller rapa is carved on the back of the right ear of the statue, whilst four ovals are incised on the left. The lobes of both ears are greatly lengthened.

* Two more are reported to have been taken by a surveying ship to Russia a few years ago, and another to Germany.

† Journ. Anthro. Inst., Jan. 1874. Trübner and Co.

* Captain Vine Hall, who spent a few hours there a year or two ago, gives the above particulars.

† There are wooden rapas in Easter Island, which are used only in the native dances.

Lower down on the back of the statue there are two herronias—symbolic animals, with albatross-like beaks, which are turned, not ungracefully, towards the bird. Immediately above the waist-belt of the statue—its only dress—there is a circle.

The explanation of these hieroglyphics is at once suggested by the story of the arrival of the chiefs. The two rapas, or steering paddles, were dedicated to the gods, and symbolise the vessels of the two chiefs. They were doubtless carved on the statue to commemorate their safe arrival. The two herronias may represent the chiefs themselves. The circle is the accepted emblem of life.

The same symbolism, though of a more realistic kind, may be recognised in the curious wooden images which are peculiar to Easter Island. They are mostly anatomical; that is, figures in which the ribs, vertebræ, and other bones are distinctly shown, as they would appear in a person suffering from extreme emaciation. They were styled by La Pérousse "squelettes." Nearly all of them have strongly marked Semitic features, a tuft on the chin, and highly symbolic carvings on the scalp; *e.g.*, herronias, double-headed birds, and a solar deity with rays round the head. The legs of these little images are uniformly short, and the ear-lobes enlarged. There is also very generally, if not always, a circle on the lower part of the back. It can hardly be doubted, in view of the symbolism which pervades almost everything in Easter Island, that these squelettes are connected with the story of the voyage from Oparo, and represent the half-starved condition in which it may well be conceived that the crews arrived.

In one of these images, in the Ethnographical Room at the British Museum, the head is perfectly smooth, which appears to intimate that it was shaven. It perhaps represents a priest; for we are informed that Roggewein, the discoverer of Easter Island in 1720, noticed a native with his head shaved, who had large "white balls" in his ears, and appeared very devout: the Dutch judged him to be a priest.

Returning to the tablets, of which casts are in the museum of the Anthropological Institute, it will be sufficient to mention that they are engraved with hieroglyphics on both sides, every part being covered with minute signs, apparently intended as actual representations of various forms of animal and vegetable life; as well as scenes and incidents such as were likely to have been met with among the islands in the Pacific. On the bottom line of what is considered to be the front face of the smaller tablet there is a procession of bird-headed men, who are approaching or standing before a pillar, or stone,* with two discs, or circles, on each side. Immediately before the first figure, which it is presumed is a chief, from his holding a staff in his hand, are two curved lines, the hieroglyphic for a boat or canoe. Behind the chief another bird-headed man is represented as kneeling down, and holding up his hands; he is probably a priest.† A third bird-headed figure follows without a staff. Then, after two small curves high up in the line of hieroglyphics—perhaps a sign for the moon,—there is a character with a bird's head and beak, of a different shape from those of the bird-headed men. It has a crest on its head, and short wings, and is probably intended for a domestic fowl—the only land bird in Easter Island. It appears to be a victim about to be sacrificed. Two more bird-headed men, without staffs, follow in a certain stately order. Then there is a second sign or hieroglyphic for a boat, followed by another chief; and then a third sign for a boat, with a waved or zigzag line before it, which is perhaps intended to signify that the vessel which follows it was lost or driven away in some other direction by a storm. This last boat is followed by a bird-headed man without a staff.

The signs for the chiefs' vessels, it will be seen, agree in number with the large rapas, or steering paddles, upon the back of the stone statue; and the bird-headed chiefs answer to the two herronias. The diminutive steering paddle, represented apart from the others on the ear of the statue, may symbolise the same casualty that appears to be signified by the waved line, viz., that there was a third boat, which did not reach Easter Island. The small carving of a rapa would thus have been erected merely *in memoriam*. However this may be, taken in conjunction with the tradition, there can be little doubt that the hieroglyphics on the tablet and the carvings on the statue relate to a more important matter than the arrival of the chiefs.

As regards the signs generally, a considerable number have been identified as conventional representations of birds and animals which are not found in Easter Island; weapons, also, and other objects are introduced (*e.g.*, an Eastern bow), which belong to regions far to the west. Some of the identifications that have been suggested may be doubtful; but amongst those that will perhaps meet with general acceptance, by no means the least important are the hieroglyphics of three distinct types of men: (1) Tall, bird-headed men, with short legs, as in the wooden images. (2) Men with large ornaments or projections on each side the head, scarcely exaggerating the practice of enlarging the ear-lobes by inserting in them discs, or plugs of wood and other materials, which prevails in certain islands in the Pacific, as well as amongst the older races in India and Burmah. (3) Dog-faced men, or Negritos, with strangely shaped heads, which, from plates in the "Cruise of the *Curaçoa*," appear to be characteristic of the natives of the Solomon Islands, as well as the more westerly islands of the Fiji group. They squat like the dog-faced men in the tablets, whilst the large-eared men sit in the Eastern manner. The peculiar appearance of the head is explained by the custom of dressing and plastering the hair. Several of these Negritos are represented about the middle of the tablet as celebrating a fish-fête; the men dancing by themselves on one side, and the women in couples on the other. Two of the men with enlarged ear-lobes stand by as spectators.

Enough has perhaps been said to suggest the great importance of an early and systematic exploration, above and below ground, of Easter Island and Oparo, as almost unworked mines, abounding in matter of the greatest ethnological and anthropological interest.

J. PARK HARRISON

* Compare the legend of the "Emigration of Turi," Pol. Myth. p. 214. "Amongst the chiefs who landed there was one called Porua . . . the second (dog) they cut up raw as an offering for the gods . . . and built a second place, *and set up pillars for the spirits*."

† See Pol. Myth. p. 136, where a priest is mentioned as accompanying a boat expedition.

ON THE DISTRIBUTION OF THE HEAT DEVELOPED BY COLLISION *

MANY of our colleagues who have become aware of a fact in thermodynamics which it has been in our power recently to observe, think it possessed of so great an interest that I ought immediately to announce it to the Academy. It is as follows:—

During the forging, which has been very successful, of the ingot of platino-iridium for the standard metre, I at first remarked that it sometimes produced, under the action of the hammer, luminous streaks, having an oblique direction upon the lateral faces of the piece, when this, while cooling, was yet at the temperature of a dull red. I showed some of these effects to M. Fizeau, but they were then incomplete, and I have only lately succeeded in obtaining a good observation of the phenomenon, and in defining its character with perfect certainty.

* A paper read by M. Tresca before the Paris Academy of Sciences June 8.

It is known that when a bar of metal is lengthened by means of a powerful hammer on an anvil of the same form as the head of the latter, each blow produces, above and below, a symmetrical contraction, the effect of which is to give to the bar the aspect of a series of projections separated by small level spaces.

At the time of the collision, these spaces, which are formed before and behind the impress of the hammer, upon the upper and the lower face of the bar, are connected, at a certain moment, upon the lateral faces, by luminous lines passing from the one to the other, and presenting altogether the appearance of an X written in lines of fire. The phenomenon is only visible for a certain temperature of bar which is being wrought, but then each blow invariably produces its effect, and, in consequence of the confused mingling of the imprints, we see the entanglement of these crossed lines which encroach upon each other. These brilliant bands appear at the same moment as the collision, but they do not disappear with it, and their continuance was sufficiently prolonged to enable us to count six luminous cross-bars visible at one time, although developed by six successive blows of the hammer.

I have been able, moreover, to get this persistence confirmed by several persons in the foundries of M. Farcot, who, with the greatest kindness, placed his services at the disposal of the Metric Commission for the execution of the work.

Although the lines of the cross-bars appeared to us all rectilinear, and although we could not compare them to anything better than two series of straight lines, parallel and intercrossed, we think it will be indispensable to determine their form more exactly by appropriate processes, and to discuss it with the greatest care.

It is well known that hammering develops heat in the bodies hammered; thermodynamics teaches us that these thermal effects ought to be regarded as the result of mechanical work or of *demi-force vive* exerted during the collision, but the precise place in which the calorific development is produced has not yet been noticed.

For ourselves, we do not hesitate to affirm that the zone which becomes luminous is that along which the matter mainly flows, at the moment when the change of form takes place, according to a law which we were enabled to discover in our previous researches in molecular displacements. If this first indication should be confirmed, there would be thus obtained a more exact knowledge of the mode of distortion determined by the forging, and the phenomenon which we describe would evidently form a new scientific connection between thermodynamics and the question with which we ourselves are personally occupied under the title of "Flowing of Solid Bodies."

The phenomenon ought to be the same for all metals, and we have already ventured to hazard some considerations of the particular causes of the brightness which it presented in the case of platinum, and which has not, so far as we know, been yet observed in any other forging.

The exceptional hardness of the platino-iridium, cooled to a dull red heat, requires, for an equal distortion, an amount of work at least equivalent to that of the forging of steel, and in consequence of the relative smallness of the calorific capacity of this alloy, this same work ought to be converted into calorific phenomena, more localised and more intense. Moreover, the material is more homogeneous than iron, and is notable for a kind of remarkable translucency which makes one believe that the eye can follow the shade of red to a certain depth. The effects, whatever they may be, are thus rendered more manifest, more especially as they are not accompanied by any exudation of foreign matter nor by any oxidation of the surface. All these circumstances are eminently favourable to the observation which chance permitted us to make, and which, once confirmed in the case of platinum, may certainly be renewed with other metals, although possibly in a more restricted manner than in the case of the alloy of MM. Deville and Debray.

We confine ourselves for the present to a summary indication of the principal fact, which appears to us to have a certain importance, and which consists in this appearance of luminous bands which arise from collision, and the position of which enables us to fix the precise place where is developed the heat which represents under another form the work done by motion: this fact is, perhaps, of a nature to open some new path for the researches, so carefully made, of the physicists of our epoch on all that touches on molecular mechanics and on the calorific actions which are connected with them.

The ingot of platinum has already been brought into the form of a bar with a square section of 4·50 m. in length; there will be a chance of continuing the same observations in the new operations of forging to which it will be submitted; the chance of renewing them may perhaps not again be offered.

SUBJECTS FOR PRIZES PROPOSED BY THE HAARLEM SOCIETY OF SCIENCES

THE following subjects for prizes are proposed by the Haarlem Society of Sciences:—

I. Competition of 1875, the limit of which is fixed on Jan. 1, 1875.

1. To give for ten sorts of glass of known chemical composition—(*a*) The coefficients of dilatation between 0° and (at the most) 100°, having regard to the influence of the tempering and the state of tension; (*b*) The coefficients of elasticity with exact indication of the temperatures; (*c*) The indices of refraction for at least ten points distributed over the whole extent of the spectrum, also with precise indication of the temperature.

2. Does the coefficient of dilatation of steel vary with the degree of tempering, and can we establish empirical laws on the subject of the connection between these two elements?

3. Can there be established by experiment a connection between the diffusion of liquids through porous partitions and other phenomena, such as capillarity, &c.?

4. Determine the coefficieut of dilatation for at least three liquids of simple composition, according to the process by which the absolute dilatation of mercury has been established.

5. Researches are sought on the origin of sensitive organs, especially of the visual organ, among some of the inferior animals; this origin being considered, as far as possible, in relation to the conditions in which the animal is found, and the external influences to which it is subject.

6. In terrestrial magnetism, what are the periods known with sufficient accuracy, and how far have these periods been proved to be connected with cosmical or telluric phenomena?

7. New experiments and observations are wanted to clear up the following question:—How are albumenoid matters formed and removed in plants?

8. Determine exactly the density, the coefficient of dilatation, the point of fusion, the point of ebullition, the specific heat, the index of refraction, and the specific rotatory power of at least twenty organic combinations, pairs of which are isomeric and whose chemical composition is known.

9. The experiments of M. Regnault on the specific heat of certain terpenes, and those of M. Berthelot on diamylene and triamylene, having shown that the specific heat of polymeric bodies of one combination may be equal to that of the fundamental matter from which they originate, it is desired that these researches be extended to as great a number as possible of other combinations having between them the same relations, for the purpose of deciding if the observed fact may or may not be raised to the rank of a general law.

10. New researches are sought on tetraphenol and its derivatives, for the purpose of deciding on the value of the hypothesis of M. Limpricht concerning the existence of a series of aromatic matters with a nucleus composed of four atoms of carbon.

11. Give a critical sketch of experiments and observations concerning the existence of *Bacteria* in contagious diseases, followed by original researches on the same question investigated in one or more of these maladies.

12. New experiments are asked on the mode of growth of bone, of such a kind as to abolish the differences of opinion founded upon results apparently contradictory, announced in recent years by various experimenters.

13. A thorough investigation is wanted of some of the species of Linnæus, chosen from among those which present more or less of varied forms. These species ought to be wild (*spontanées*) plants, to the number of ten at least, and of twenty or more, belonging to two natural families at least, and inhabiting well-explored countries, such as Europe, the United States, &c. The author ought to discover, describe, and classify all the forms more or less distinct, and more or less hereditary, which are included in the Linnean species, being careful to intimate their habitat, their station. He ought to study their mode of fecundation, and to judge how far certain forms may be attributed to crossing. The classification of forms into species, races, varieties, and other subdivisions as may be necessary, ought to be based at once upon the external forms and on the more intimate affinities demonstrated by fecundation and grafting.

II. For competition in 1876, for which the limit is fixed on Jan. 1, 1876.

1. Exact researches are asked for concerning the dissolving power of water, and of water charged with carbonic acid, for gypsum, chalk, and dolomite, at different temperatures and pressures, and in the case of the simultaneous presence of marine salt and other common soluble salts.

2. The same is asked for silex and the most common natural silicates.

3. To submit to a new investigation the structure of the kidneys of Mammalia, specially in reference to the epithelial lining of the different parts of the renal tubes.

4. A critical examination of recent researches from which it would appear to result that the peptones of different albumenoid matters are mixtures of substances in part already known and partly yet unknown. This critical examination should be completed by personal researches.

5. To determine exactly in Weber units, the resistance of a column of mercury of one metre in length and of one square millimetre in section, at 0°.

6. To make better known, by careful experiments, the relation between the two kinds of electrical units, electro-magnetic units and electro-static units.

7. New experiments tending to determine the influence of pressure on chemical action.

The prize offered by the Society for each of these questions consists (at the choice of the competitors) either of a gold medal bearing the ordinary stamp of the Society, along with the name of the author and the date, or a sum of 150 florins. A supplementary premium of 150 florins may, moreover, be awarded if any memoir is deemed worthy of it. The memoirs sent for competition ought to be written in one of the following languages:—French, Dutch, English, Italian, Latin, or German (but not in German character). They ought to be accompanied by a sealed envelope containing the name of the author, who ought not to make himself otherwise known.

COMMON WILD FLOWERS CONSIDERED IN RELATION TO INSECTS *

AT the close of the last century, Conrad Sprengel published a most valuable work on Flowers, in which he pointed out that their forms and colours, their scent, honey, and general structure, have reference to the visits of insects, which are of importance to Flowers in transferring the pollen from the stamens to the pistil. Sprengel's admirable work, however, did not attract the attention it deserved, and remained comparatively unknown until Mr. Darwin devoted himself to the subject. Our illustrious countryman was the first to perceive that insects are of importance to Flowers, not only in transferring the pollen from the stamens to the pistil, but in transferring it from the stamens of one flower to the pistil of another. Sprengel had, indeed, observed in more than one instance that this was the case; but he did not appreciate the importance of the fact. Mr. Darwin's remarkable memoir on Primula, to which I shall again have occasion to refer more than once, was published in 1862; in this treatise the importance of cross-fertilisation, as it may be called, was conclusively proved, and he has since illustrated the same rule by a number of researches on Orchids, Linum, Lythrum, and a variety of other plants. The new impulse thus given to the study of Flowers has been followed up in this country by Hooker, Ogle, Bennett, and other naturalists, and on the Continent by Axell, Delpino, Hildebrand, and especially by Dr. H. Müller, who has published an excellent work on the subject, bringing together the observations of others and adding to them an immense number of his own.

Everyone knows how important flowers are to insects; everyone knows that bees, butterflies, &c., derive the main part of their nourishment from the honey or pollen of flowers; but comparatively few are aware, on the other hand, how much the flowers themselves are dependent on insects.

Yet it is not too much to say, if flowers are very useful to insects, insects, on the other hand, are in many cases absolutely necessary to flowers; that if insects have been in some respects modified and adapted with a view to the acquirement of honey and pollen; flowers, on the other hand, owe their scent and colours, nay, their very existence in the present form, to insects. Not only have the brilliant colours, the smell, and the honey of flowers been gradually developed under the action of natural selection to encourage the visits of insects, but the very arrangement of the colours, the circular bands and radiating lines,* the form, size, and position of the petals, are arranged with reference to the visits of insects, and in such a manner as to ensure the grand object which renders these visits necessary. Thus the lines and bands by which so many flowers are ornamented have reference to the position of the honey; and it may be observed that these honey-guides are absent in night-flowers, where of course they would not show, and would therefore be useless, as, for instance, in *Lychnis vespertina*, or *Silene nutans*. Night-flowers, moreover, are generally pale; for instance, *Lychnis vespertina* is white, while *Lychnis diurna* which flowers by day is red.

That the colour of the corolla has reference to the visits of insects is well shown by the case of flowers, which—as, for instance, the ray or outside florets of *Centaurea cyanus*—have neither stamens nor pistils, and serve, therefore, exclusively to render the flower-head more conspicuous. The calyx, moreover, is usually green; but when the position of the flower is such that it is much exposed, it becomes brightly coloured, as, for instance, in the Berberry.

If it be objected to me that I am *assuming* the existence of these gradual modifications, I should reply that it is not here my purpose to discuss the doctrine of Natural Selection. I may, however, remind the reader that Mr. Darwin's theory is based on the following considerations:—1. That no two animals or plants in nature are identical in all respects. 2. That the offspring tend to inherit the peculiarities of their parents. 3. That of those which come into existence only a certain number reach maturity. 4. That those which are, on the whole, best adapted to the circumstances in which they are placed, are most likely to leave descendants.

No one of these statements is, or can be, disputed, and they seem fully to justify the conclusions which Mr. Darwin has deduced from them, though not all those which have been attributed to him by his opponents.

Now, applying these considerations to flowers, if it is an advantage to them that they should be visited by insects (and that this is so will presently be shown), then it is obvious that those flowers which, either by their larger size, or brighter colour, or sweeter scent, or greater richness in honey, are most attractive to insects, will, *ceteris paribus*, have an advantage in the struggle for existence, and be most likely to perpetuate their race.

There are, indeed, other ways in which insects may be useful to plants. Thus, a species of acacia mentioned by Mr. Belt,† if unprotected, is apt to be stripped of its leaves by a species of leaf-cutting ant, which uses the leaves, not directly for food, but, according to Mr. Belt, to grow mushrooms on.

The acacia, however, bears hollow thorns, and each leaflet produces honey in a crater-formed gland at the base, and a small, sweet, pear-shaped body at the tip. In consequence it is inhabited by myriads of a small ant, *Pseudomyrma bicolor*, which nests in the hollow thorns, and thus finds meat, drink, and lodging all provided for it. These ants are continually roaming over the plant, and constitute a most efficient bodyguard, not only driving off the leaf-cutting ants, but even in Mr. Belt's opinion rendering it less liable to be eaten by herbivorous mammalia.

* Address by Sir John Lubbock, Bart., F.R.S., at the Belfast meeting of the British Association, August 1874.

* I did not realise the importance of these guiding marks until, by experiments on bees, I saw what difficulty they experience if honey, which is put out for them, is moved even slightly from its usual place.

† F. Müller has observed similar facts in Sta. Catharina. (NATURE, vol. x. p. 102.)

We are now, however, more immediately concerned with bees and flowers.

Many flowers close their petals during rain, which is obviously an advantage, since it prevents the honey and pollen from being spoilt or washed away. Everybody, however, has observed that even in fine weather certain flowers close at particular hours. This habit of going to sleep is surely very curious. Why should flowers do so?

In animals we can understand it; they are tired and require rest. But why should flowers sleep? Why should some flowers do so and not others? Moreover, different flowers keep different hours. The daisy opens at sunrise and closes at sunset, whence its name "day's-eye." The dandelion (*Leontodon taraxacum*) is said to open at seven and close at five, *Arenaria rubra* to be open from nine to three, *Nymphæa alba* from about seven to four: The common Mouse-ear Hawkweed (*Hieracium pilosella*) is said to waken at eight and go to sleep at two; the scarlet pimpernel (*Anagallis arvensis*) to wake at seven and close soon after two; while *Trogopogon pratensis* opens at four in the morning, and closes just before twelve, whence its English name, "John go to bed at noon." Farmers' boys in some parts are said to regulate their dinner-time by it. Other flowers, on the contrary, open in the evening.

Now, it is obvious that flowers which are fertilised by night-flying insects would derive no advantage from being open by day; and, on the other hand, that those which are fertilised by bees would gain nothing by being open at night. Nay, it would be a distinct disadvantage, because it would render them liable to be robbed of their honey and pollen, by insects which are not capable of fertilising them. I would venture to suggest, then, that the closing of flowers may have reference to the habits of insects, and it may be observed also in support of this that wind-fertilised flowers never sleep; * and that some of those flowers which attract insects by smell emit their scent at particular hours: thus, *Hesperis matronalis* and *Lychnis vespertina* smell in the evening, and *Orchis bifolia* is particularly sweet at night.

I now pass to the structure and modification of flowers. A perfect flower consists of (1) an outer envelope or *calyx*, sometimes tubular, sometimes consisting of separate leaves, called *sepals*; (2) an inner envelope or *corolla*, which is generally more or less coloured, and which, like the calyx, is sometimes tubular, sometimes composed of separate leaves, called *petals*; (3) of one or more *stamens*, consisting of a stalk or *filament*, and a head or *anther*, in which the pollen is produced; and (4) a *pistil*, which is situated in the centre of the flower, and consists generally of three principal parts—one or more *carpels* at the base, each containing one or more seeds; the stalk or *style*; and thirdly the *stigma*, which in many familiar instances forms a small head at the top of the style or ovary, to which the pollen must find its way in order to fertilise the flower. In some cases the stigma is sessile. Thus it will be seen that the pistil is normally surrounded by a row of stamens, and it would seem at first sight a very simple matter that the pollen of the latter should fall on the former.

This in fact does happen in many cases, and flowers which thus fertilise themselves have evidently one great advantage—few remain sterile for want of pollen. Everyone, however, who has watched flowers and has observed how assiduously they are visited by insects, will admit that these insects must often deposit on the stigma, pollen brought from other plants, generally of the same species. For it is a remarkable fact that in most cases bees confine themselves in each journey to a single species of plant, though in the case of some very nearly allied forms this is not so; for instance, it is stated on good authority that *Ranunculus acris*, *R. repens*, and *R. bulbosus* are not distinguished by the bees, or at least are visited indifferently, as is also the case with two of the species of clover, *Trifolium fragiferum* and *T. repens*. Now, it is clear, both from the structure of flowers and also from direct experiment, that as a general rule it is an advantage to flowers to be fertilised by pollen from a different plant.

I will not now enter on the large question why this confertilisation should be an advantage; but that it is so has been clearly proved. It has long been known that hybrids between different varieties are often remarkably strong and vigorous; Kolrenter speaks with astonishment of the "*statura portentosa*" of some plants thus raised by him; indeed, says Mr. Darwin,* all experimenters have been struck with the wonderful vigour, height, size, tenacity of life, precocity, and hardiness of their hybrid productions. Mr. Darwin himself, however, was, I believe, the first to show that if a flower is fertilised by pollen from a different plant, the seedlings so produced are much stronger than if the plant is fertilised by its own pollen. I have had the advantage of seeing several of these experiments, and the difference is certainly most strtiking. For instance, six crossed and six self-fertilised seeds of *Ipomœa purpurea* were grown in pairs on opposite sides of the same pots; the former reached a height of 7 ft., while the others were on an average only 5 ft. 4½ in. The first also flowered more profusely. It is also remarkable that in some cases plants are themselves more fertile if supplied with pollen from a different flower, a different variety, and even as it would appear in some cases, as in the Passion Flower, for instance, of a different species. Nay, in some cases it would seem that pollen has no effect whatever unless transferred to a different flower. In Pulmonaria, for instance, the pollen is said to be entirely without effect on the stigma of the same plant. Fritz Muller has made a variety of experiments on this interesting subject, which seem to show that in some cases, pollen, if placed on the stigma of the same flower, has no more effect than so much inorganic dust; while, which is perhaps even more extraordinary, in others the pollen placed on the stigma of the same flower acted on it like a poison. This he observed in several species: the flower faded and fell off; the pollen masses themselves, and the stigma in contact with them, shrivelled up, turned brown, and decayed; while other flowers on the same branch, which were left un fertilised, retained their freshness.

* Sprengel, "Das entdeckte Geheimniss der Natur," p. 291.
† Animals and Plants under Domestication, ch. xvii.

We will now pass to the consideration of the means by which self-fertilisation is checked, and cross-impregnation is effected, in plants. In some cases the pollen is simply wind-borne, in others it is carried by insects. These are attracted partly by the pollen itself, partly by the honey; while the bright colour and the scent serve to indicate the spot where the pollen and honey can be found. The calyx, which is not generally brightly coloured, probably serves as a protection to the honey, and tends to prevent bees and other insects from obtaining access to it by force.

In many cases self-fertilisation is prevented by the separation of the stamens and pistils, either in the place they occupy, or the time of their maturity. They are frequently situated, either in different flowers of the same plant, as in Euphorbia, or in different plants, as in the Hop; in other cases, although the stamens and pistils are situated in the same flower, they do not mature at the same time, the anthers in some cases producing their pollen before the pistil is ready to receive it, as was first observed in *Epilobium angustifolium* by Sprengel, in the year 1790;* while in others the reverse is the case, and the pistil, on the contrary, comes to maturity before the pollen is formed. But even when the stamens and pistils are situated in the same flower and ripen at the same time, they are sometimes so placed that it is difficult for the pollen to reach the stigma.

Moreover, it appears that if a supply of pollen from another plant is secured, it is comparatively unimportant to exclude the pollen of the plant itself, for in such cases the latter is neutralised by the more powerful effect of the former.

It is also interesting to notice that the contrivances by which cross-fertilisation is favoured, or ensured, are probably of very different geological antiquity. Thus, as Müller has pointed out,† the special peculiarities of the Umbelliferæ and Compositæ have been inherited respectively from the ancestral forms of those orders; those of Delphinium, Aquilegia, Linaria, and Pedicularis, from the ancestral forms of the respective genera; those of *Polygonum fagopyrum*, *P. bistorta*, *Lonicera caprifolium*, &c., from the ancestors of those species; while in *Lysimachia vulgaris*, *Rhinanthus cristagalli*, *Veronica spicata*, *Euphrasia odontites*, and *E. officinalis*, we find that differences have arisen even within the limits of one and the same species.

The transference of the pollen from one flower to another, as I have already mentioned, is effected principally, either by the wind or by insects. In the former case the flower is rarely conspicuous; indeed, Mr. Darwin finds it "an invariable rule that when a flower is fertilised by the wind it never has a gaily-coloured corolla." The conifers, grasses, birches, poplars, &c., belong to this category.

In such plants a much larger quantity of pollen is required than where the fertilisation is effected by insects. Everyone has observed the showers of yellow pollen produced by the Scotch fir. Again, it is an advantage to these plants to flower before the leaves are out, because the latter would greatly interfere with

* "Das entdeckte Geheimniss der Natur."
† Müller, p. 44.

the access of the pollen to the female flower. Hence such plants as a rule flower early in the spring. Again, in such flowers the pollen is less adherent, so that it can easily be detached by the wind,* which would manifestly be a disadvantage in the case of most of those flowers which are fertilised by insects.

Such flowers generally have the stigma more or less branched or hairy, which evidently must tend to increase their chances of catching the pollen.

It is an almost invariable rule that wind-impregnated flowers are inconspicuous, but the reverse does not hold good, and there are many flowers which, though habitually visited by insects, are not brightly coloured. In some cases flowers make up by their numbers for the want of individual conspicuousness. In others the insects are attracted by scent; indeed, as has already been mentioned, the scent, as well as the colours of flowers, has no doubt been greatly developed through natural selection, as an attraction to insects.* But though bright colours and strong odours are sufficient to attract the attention of insects, something more is required. Flowers, however sweet smelling or beautiful, would not be visited by insects unless they had some more sub-

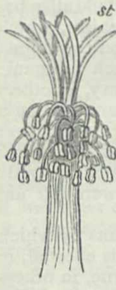

FIG. 1.

FIG. 2.

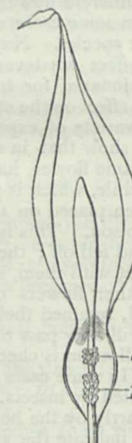

FIG. 3.

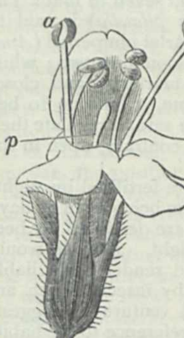

FIG. 4.

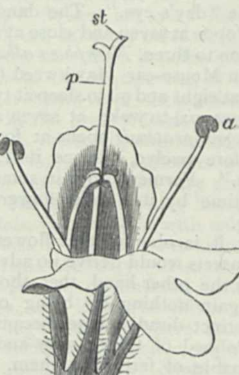

FIG. 5.

stantial advantages to offer. These advantages are the pollen and the honey; though it appears that some flowers beguile insects by holding out the expectation of honey which does not really exist, just as some animals repel their enemies by resembling other species which are either dangerous or disagreeable.

The pollen, of course, though very useful to insects, is also essential to the flower itself; but the scent and the honey, at least in their present development, are mainly useful to the plant in securing the visits of insects, and the honey also sometimes in causing the pollen to adhere to the proboscis of the insect. Among other obvious evidences that the beauty of flowers is useful in consequence of its attracting insects, we may adduce those cases in which the transference of the pollen is effected in different manners in nearly allied plants, sometimes even in different species belonging to the same genus.

Thus, *Malva sylvestris* and *Malva rotundifolia*, which grow in the same localities, and therefore must come into competition, are nevertheless nearly equally common. In both species the young flowers contain a pyramidal group of stamens which surround the as yet immature pistil, and produce a large quantity

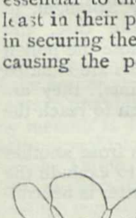

FIG. 6.

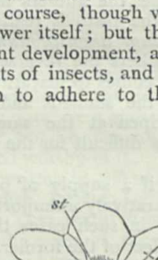

FIG. 7.

FIG. 8.

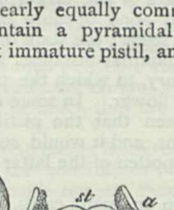

FIG. 9.

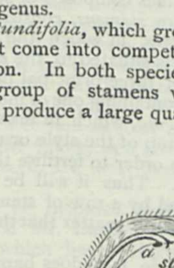

FIG. 10.

of pollen, which cannot fail to dust any insect which may visit the flower for the sake of its honey. In *Malva sylvestris* (Fig. 1), where the branches of the stigma are so arranged that the plant cannot fertilise itself, the petals are large and conspicuous, so that the plant is visited by numerous insects; while in *Malva rotundifolia* (Fig. 2), the flowers of which are comparatively small and are rarely visited by insects, the branches of the stigma are elongated and twine themselves among the stamens, so that the flower can hardly fail to fertilise itself.

Another remarkable instance occurs in the genus Epilobium, which is, moreover, specially interesting, because in *E. angustifolium*, as I have already mentioned, the curious fact was first noticed that the pistil did not mature until the stamens had shed their pollen. *E. angustifolium* has conspicuous purplish-red

* On the other hand, it is an advantage to wind-borne seeds to be somewhat tightly attached, because they are then only removed by a high wind which is capable of carrying them some distance.

* In confirmation of this it is stated that when insects are excluded, the blossoms last longer than is otherwise the case; that when flowers are once fertilised, the corolla soon drops off, its function being performed.

flowers, in long terminal racemes, and is much frequented by insects; *E. parviflorum*, on the contrary, has small solitary flowers, and is seldom visited by insects. Now, to the former species the visits of insects are necessary, since the stamens ripen before the pistil, and the flower has consequently lost the power of self-fertilisation. In the latter, on the contrary, the stamens and pistil come to maturity at the same time, and the flower habitually fertilises itself. It is, however, no doubt sometimes crossed by the agency of insects; and indeed I am disposed to believe that this is true of all flowers which are either coloured or sweet scented. The degree in which flowers are dependent on insects differs very much, and it seems to be a general rule that in any genus where the flowers differ much in size, the largest ones are specially dependent on insects.

As already mentioned, the self-fertilisation of flowers is in other cases still more effectually guarded against by the fact that the stamens and pistils do not ripen at the same time.

In some cases the pistil ripens before the stamens. Thus the Aristolochia has a flower which consists of a long tube with a narrow opening closed by stiff hairs which point backwards, so that it much resembles an ordinary eel-trap. Small flies enter the tube in search of honey, which from the direction of the hairs they can do easily, though on the other hand, from the same cause, it is impossible for them to return. Thus they are imprisoned in the flower; gradually, however, the pistil passes

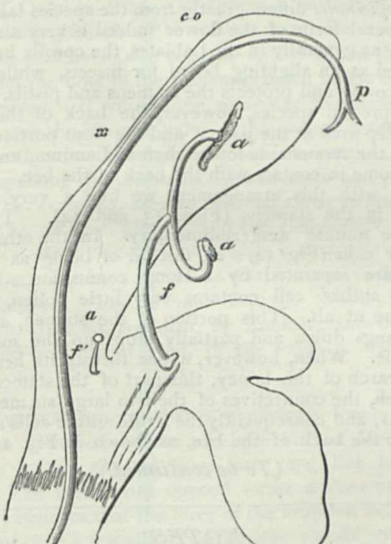

Fig. 11

maturity, the stamens ripen and shed their pollen, by which the flies get thoroughly dusted. Then the hairs of the tube shrivel up and release the prisoners, which carry the pollen to another flower.

Again, in the common Arum (Fig. 3), we find a somewhat similar mode of fertilisation. The well-known green leaf encloses a central pillar which supports a number of pistils near the base, and of anthers somewhat higher. Now, in this case nothing would at first sight seem easier or more natural than that the pollen from the anthers should fall on and fertilise the pistils. This, however, is not what occurs. The pistils (*p*) mature before the anthers (*a*), and by the time the pollen is shed have become incapable of fertilisation. It is impossible, therefore, that the plant should fertilise itself. Nor can the pollen be carried by wind. When it is shed it drops to the bottom of the tube, where it is so effectually sheltered that nothing short of a hurricane could dislodge it; and although Arum is common enough, still the chances against any of the pollen so dislodged being blown into the tube of another plant would be immense.

As, however, in Aristolochia, so also in Arum, small insects which, attracted by the showy central spadix, the prospect of shelter or of honey, enter the tube while the stigmas are mature, find themselves imprisoned, as the fringe of hairs, while permitting their entrance, prevents them from returning. After a while, however, the period of maturity of the stigmas is over, and each secretes a drop of honey, thus repaying the insects for their captivity. The anthers then ripen and shed their pollen, which falls on and adheres to the insects. Then the hairs gradually shrivel up and set the insects free, carrying the pollen with them, so that those which then visit another plant can hardly fail to deposit some of it on the stigmas. Sometimes more than a hundred small flies will be found in a single Arum. In these two cases there is obviously a great advantage in the fact that the stigmas arrive at maturity before the anthers. Generally, however, the advantage is the other way, and the stamens ripen before the pistil.

Of this we may take the thyme or the marjoram as an illustration. The flowers are crowded together, and as the stigmas do not come to maturity until all the anthers in the same head have shed their pollen, it is obvious that bees creeping over the

Fig. 12.

flowers must transfer the pollen from the anthers of one head to the pistils of another.

Fig. 4 represents a flower of the thyme (*Thymus serpyllum*), and shows the four ripe stamens, and the short, as yet undeveloped pistil. Fig. 5, on the contrary, represents a somewhat older flower, in which the stamens are past maturity, while the pistil, on the other hand, is considerably elongated, and is ready for the reception of the pollen.

Here it is at once obvious that insects alighting on the younger (male) flowers would dust themselves with pollen, some of which, if they subsequently alighted on an older flower, they could not fail to deposit on the stigma. It should also be mentioned that in this genus there are likewise some small flowers which contain no stamens. In some cases flowers which are first male and then female, are male on the first day of opening, female on the second. In others the period is longer. Thus

Fig. 13.

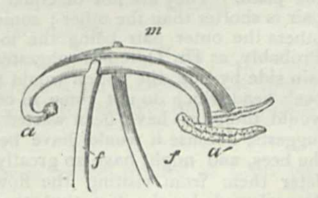

Fig. 14.

Nigella, according to Sprengel, is male for six days, after which the stigma comes to maturity and lasts for three or four.*

Fig. 6 represents a flower of *Myosotis versicolor*, a species often known as the Forget-me-not, when just opened. It will be observed that the pistil projects above the corolla and stamens, so that it must be first touched by any insect alighting on the flower. Gradually, however, the corolla elongates, carrying up the stamens with it, until at length they come opposite the stigma, as shown in Fig. 7. Thus, if the flower has not already been fertilised by insects, it is almost sure to fertilise itself.

I will now call attention in more detail to some of our common wild flowers, in order to show how beautifully they are adapted to profit by the visits of insects, and how the various parts are arranged so as to favour not only the transfer of pollen from one flower to another, but also its deposition on that part of the

* "Das entdeckte Geheimniss der Natur," p. 287.

pistil which is especially prepared for its reception. Wherever the pistil projects beyond the stamens, it is obvious that a bee alighting on the flower would come in contact first with the former and subsequently with the latter. In flying from flower to flower, therefore, she would generally fertilise each with the pollen of one which had been previously visited.

Fig. 8 represents the common Berberry. *f f* represent the stamens, which lie close to the petals and almost at right angles to the pistil (*s t*), as shown in the figure. The honey-glands (*n n*) are twelve in number, situated in pairs at the base of the petals, so that the honey runs down into the angle between the bases of the stamens and of the pistil. The papillary edge of the summit of the pistil (*s t*) serves as the stigma. In open flowers of this kind it is of course obvious that insects will dust themselves with the pollen and then carry it with them to other flowers. In Berberis, however, both advantages, the dusting and the cross-fertilisation, are accomplished by a very curious contrivance. The bases of the stamens are highly irritable, and when an insect touches them the stamens spring forward (Fig. 9) and strike the insect. The effect of this is not only to shed the pollen over the insect, but also in some cases to startle it and drive it away, so that it carries the pollen, thus acquired, to another flower.

In few flowers is the adaptation of the various parts to the visits of insects more clearly and beautifully shown than in the common white Dead Nettle (*Lamium album*), Fig. 10. The honey occupies the lower contracted portion of the tube (Fig. 10, *c a*), and is protected from the rain by the arched upper lip and by a thick rim of hairs. Above the narrower lower portion the tube expands and throws out a broad lip (Fig. 10, *m*), which serves as an alighting place for large bees, while the length of the narrow tube prevents the smaller species from obtaining access to the honey, which would be injurious to the flower, as it would remove the source of attraction for the bees, without effecting the object in view. At the base of the tube, moreover, there is a ring of hairs, which prevent small insects from creeping down the tube and so getting at the honey. Lamium, in fact, like so many of our other wild flowers, is especially adapted for humble-bees. They alight on the lower lip (Fig. 10, *m*), which projects at the side so as to afford them a leverage by means of which they may press the proboscis down the tube to the honey; while on the other hand the arched upper lip, in its size, form, and position, is admirably adapted not only as a protection against rain, but also to prevent the anthers (Fig. 10, *a a*) and pistil (Fig. 10, *s t*) from yielding too easily to the pressure of the insect, and thus to ensure that it presses the pollen which it has brought from other flowers against the pistil.

The stamens do not form a ring round the pistil, as is so usual. On the contrary, one stamen is absent or rudimentary, while the other four lie along the outer arch of the flower, on each side of the pistil. They are not of equal length, as is usual, but one pair is shorter than the other; sometimes the inner pair, and at others the outer pair being the longest. Now, why is this? Probably, as Dr. Ogle has suggested, because if the anthers had lain side by side, the pollen would have adhered to parts of the bee's head which do not come in contact with the stigma, and would therefore have been wasted; perhaps also partly, as he suggests, because it would have been deposited on the eyes of the bees, and might have so greatly inconvenienced them as to deter them from visiting the flower. Dr. Ogle's opinion is strengthened by the fact that there are some species, as for instance the Foxglove, in which the anthers are transverse when immature, but become longitudinal as they ripen.

But to return to the Dead Nettle. From the position of the pistil which hangs down below the anthers, the bee comes in contact with the former before touching the latter, and consequently generally deposits upon the stigma pollen from another flower. The small processes (Fig. 10, *m*) on each side of the lower lip are the rudiments of the lateral leaves with which the ancestors of the Lamium were provided. Thus, then, we see how every part of this flower, is either, like the size and shape of the arched upper lip, the relative position of the pistil and anthers, the length and narrowness of the tube, the size and position of the lower lip, the ring of hairs and the honey, adapted to ensure the transference, by bees, of pollen from one flower to another; or, like the minute lateral points, is an inheritance from more highly developed organs of ancestors. If we compare Lamium with other flowers we shall see how great a saving is effected by this beautiful adaptation. The stamens are reduced to four, the stigma almost to a point; how great a contrast with the pines and their clouds of pollen; or even with such a flower as the Nymphæa, where the visits of insects are secured, but the transference of the pollen to the stigma is, so to say, accidental. Yet the fertilisation of Lamium is not less effectually secured than in either of these.

In this flower it would appear, as already mentioned, that the pistil matures as early as the stamens, and that cross-fertilisation is obtained by the relative position of the stigma, which, as will be seen in the figure, hangs down below the stamens, so that a bee bearing pollen on its back from a previous visit to another flower would touch the pistil and transfer to it some of this pollen before coming in contact with the stamens.

In other species belonging to the same great group (Labiatæ) the same object is secured by the fact that the stamens come to maturity before the pistils have shed their pollen, and shrivelled up before the stigma is mature.

Fig. 11 represents a young flower of *Salvia officinalis* * in which the stamens (*a*) are mature, but not the pistil (*p*), which moreover from its position is untouched by bees visiting the flower. The anthers as they shed their pollen gradually shrivel up; while on the other hand the pistil increases in length and curves downwards, until it assumes such a position that it must come in contact with any bee visiting the flower, and would touch just that part of the back on which pollen would be deposited by a younger flower. In this manner self-fertilisation is effectually provided against. There are, however, several other points in which *S. officinalis* differs greatly from the species last described.

The general form of the flower indeed is very similar. We find again, as generally in the Labiates, the corolla has the lower lip adapted as an alighting board for insects, while the arched upper lip covers and protects the stamens and pistils.

In the present species, however, the back of the upper lip shows a deep arch at the part *x*, and the front portion of the lip, containing the stamens, is loftier than in Lamium, and does not therefore come in contact with the back of the bee. In evident correlation with this arrangement we find a very remarkable difference in the stamens (Figs. 13 and 14). Two of the stamens are minute and rudimentary. In the other pair the two anther cells (Fig. 14, *a a*), instead of being as usual close together, are separated by a long connection. Moreover, the lower anther cell contains very little pollen, sometimes indeed none at all. This portion of the stamen, as shown in Fig. 13, hangs down and partially stops up the mouth of the corolla tube. When, however, a bee thrusts its head into the tube in search of the honey, this part of the stamen is pushed into the arch, the connectives of the two large stamens revolve on their axis, and consequently the fertile anther cells are brought down on to the back of the bee, as shown in Fig. 12.

(*To be continued.*)

* The *Popular Science Review* for July 1869 contains a very clear and interesting paper by Dr. Ogle on this genus.

NOTES

The German Government has determined upon the erection of a Sun Observatory ("*Sonnen-Warte*") upon a large scale at Potsdam. Drs. Spoerer and Vogel have already been appointed to undertake the telescopic and spectroscopic observations, and the directorship has been offered to Prof. Kirchhoff, who, however, has declined it, as he is unwilling to leave Heidelberg.

The International Congress of Orientalists was opened in London on Monday, by an address from Dr. Birch. We hope to give an account of the proceedings in our next number.

We are glad to see that a contemporary not specially devoted to science—the *Morning Post*—in an article on Dr. Hooker's address at Belfast, points out to its readers that the majority of the observations referred to could be made "by any intelligent person without any scientific training," and expresses a hope that "people who have the opportunities for cultivating, and leisure for observing, will make collections of plants . . . . and add to our stock of knowledge." At the same time it suggested these as interesting subjects for observation:—"How much can plants eat in twenty-four hours? When do they eat most? Under what conditions of weather? &c. Indeed, the whole field is one that is almost unexplored." May this hint, which will reach many who are not readers of scientific papers, not be without result! We would draw attention to the fact that plants of *Drosera rotundifolia* are advertised for sale at ninepence each, and we hope that before long some enterprising dealer may make a speciality of all known carnivorous plants for suitable observations.

AT the Botanic Garden, Oxford, the Mexican *Dasylirion arcotrichum* recently threw-up a flower stem which, when 12 ft. high, grew at the rate of six inches in twenty-four hours. The *Nelumbium luteum* (the sacred bean) is reported this season as producing perfect seeds.

AN *Annuaire de l'Horticulture Belge* is announced as soon to appear.

THE last number of the *Gardener's Chronicle* gives a drawing of four lopped elms growing near Datchet, the tops of which have naturally grown with the outline of a horse.

THE Academy of Sciences in Copenhagen announces the subject for a prize essay, to be addressed to it through its secretary by the end of October 1875. It desires a memoir that shall collect in chronological order the various determinations of constant quantities that have been used in spherical and theoretical astronomy from the time of the Ptolemies down to the end of the eighteenth century. It will not be necessary to submit to any critical discussion the intrinsic value of the various constants, but simply to give them in as complete a manner as possible. Special researches respecting the proper motions of stars and parallaxes of stars will be excluded, as also will be those relating to the satellites of the exterior planets, and the elements of orbits of comets. It is desired principally to obtain a complete collection of those numbers that have served as the basis of earlier astronomical researches. The memoir may be written in either Latin, French, German, Swedish, or English; and the medal to be awarded will be of gold, of the value of 320 Danish crowns.

PROF. SILVESTRI reports that a transversal fissure about a mile long has appeared on the northern side of Mount Etna. Twenty fresh craters situated upon one long line have been thrown up. The first crater opened forms a cone 75 ft. high. Prof. Silvestri believes that the force of the eruption is at present spent, and that only a few slight earthquake shocks will now be felt.

M. N. RAUÏS, Assistant Secretary of the Belgian Royal Academy of Sciences (Brussels), proposes to publish a work having for its title "Dictionnaire universel des académies, sociétés savantes, observatoires, universités, musées, archives, bibliothèques, jardins botaniques," &c.,—a methodical catalogue of all establishments which contribute to the progress of science, letters, and the arts. M. Rauïs, to enable him to carry out his praiseworthy scheme, requests the managing officials of institutions of the kind indicated to furnish him with the needful information in the form indicated by the following questions:—1. Title of the establishment. 2. Date of foundation, creation, &c. 3. Its aim. 4. Titles of the directorate. 5. Seat of the Institution, with its exact address. 6. Meetings, prizes, &c. 7. Does the establishment possess a library, archives, museum, cabinet of medals or antiquities, observatories, laboratories? 8. Publications:—Number and nature (bulletin, reviews, annals or memoirs); number of volumes published from the commencement; the easiest way of procuring these publications, whether by purchase or exchange. 9. All other useful information not comprised in the preceding questions. We hope all our British scientific institutions, societies, and clubs, will aid M. Rauïs in his important undertaking.

AN exhibition of photographs, &c., in connection with the Photographic Society will be opened on October 13, at the Suffolk Street Gallery. Specimens will be received up to October 7. We have on former occasions pointed out that photography has a scientific as well as a purely artistic interest, and the present opportunity should not be allowed to pass without illustrations of what photography has done to advance pure science. Mr. John Spiller, F.C.S., has been elected President, and Mr. R. J. Friswell, F.C.S., Hon. Sec. of the Society, so that the interest of science will have a good chance of being in future attended to.

WE have received the prospectus of the Owens College School of Medicine for Session 1874–5, the professorate of which has recently been completed by the appointment of Dr. M. Watson to the chair of Anatomy. The new buildings will be opened by Prof. Huxley, F.R.S., on Friday, Oct. 2, at 3 P.M.

THE Exhibition of useful and noxious insects in Paris, which we announced (vol. x. p. 295), was opened last week in the Tuileries Gardens, and promises to be highly interesting and useful.

PROF. VON RATH, of Bonn, in *Poggendorff*, describes under the name *Foresite* a new mineral of the Zeolite family, from the granite of Elba. It is named in honour of its discoverer, Sig. Foresi, of Portoferrajo, in Elba, who found it in druses which were covered with felspar, oligoclase, quartz, lithia, and tourmaline, on which, along with Desmin [stilbite] and Stilbite [Heulandite] it forms incrustations. Foresite belongs to the prismatic system; has a similar appearance to Desmin, with surfaces bright as mother-of-pearl. The angular measurements, like the faces, indicate that it is isomorphous with Desmin. Its water, which amounts to 15·31 per cent., is entirely driven off at a red heat under the blowpipe. It decomposes with difficulty in hydrochloric acid, and its silica does not gelatinise. A mean of three analyses shows it to consist of—

Silica	49·96
Alumina	27·40
Lime	5·47
Magnesia	·40
Potash	·77
Soda	1·38
Water	15·07
	100·45

Von Rath regards its chemical formula as—

$$Na_2O,\ 3CaO,\ 8Al_2O_3,\ 24SiO_2,\ 24H_2O,$$

and thus it makes a further approximation to Desmin. It differs from all known Zeolites in the small proportion of lime to alumina and silica.

AN International Exhibition is to be opened at Chili on Sept. 16, 1875.

THERE has been started at Mevagissey, Cornwall, a manufactory of "Cornish sardines," the sardines being pilchards preserved in oil, immense quantities of which have hitherto been used as manure, or returned to the sea as of no use. We believe these Cornish sardines are at least equal to the sardines commonly imported into this country.

THE *Times* Alexandria correspondent, under date Sept. 6, states that Mr. H. M. Stanley passed through Egypt a few days previously on his way to Zanzibar. An ingeniously constructed boat, built for Mr. Stanley's expedition, was recently tried on the Thames.

WE have received the programme of the many-sided Birmingham and Midland Institute for 1874–75. Sir John Lubbock, Bart., F.R.S., delivers the inaugural address on Nov. 5, and among the other special lectures announced are two on "Cor l

Animals and Coral Islands," by Prof. W. C. Williamson, F.R.S.; "Assyrian Mythology," by Mr. George Smith; two on "The Education of the People," by Prof. W. K. Clifford; "Vitality in Men and in Races," by Dr. B. W. Richardson, F.R.S.; "A Night at Lord Rosse's Telescope," and "The Pendulum," by Prof. Ball, F.R.S.

THE following candidates have been successful in obtaining Royal Exhibitions of 50*l.* per annum, each for three years, and free admission to the course of instruction at the following institutions:—(1) To the Royal School of Mines, Jermyn Street, London: Charles W. Folkard, Lawrence J. Whalley, Alfred N. Pearson. (2) To the Royal College of Science, Dublin: Thomas Bayley, William Fream, Archibald N. McAlpine.

MR. RAMSAY WRIGHT, M.A., B.Sc., Assistant to the Professor of Natural History, Edinburgh University, has been appointed to the Chair of Natural History, University College, Toronto. Mr. Wright succeeds Prof. Alleyne Nicholson, now of the Newcastle College of Science.

PROF. E. S. HOLDEN, U.S. Navy, forwards us a letter from Mr. H. G. Wright, dated San Bernardino, Cal., Aug. 2, 1874, describing a small lake or pond in New Hampshire having two outlets, and with which he has been perfectly familiar from boyhood. "Neither of the outlets," the writer states, "ever dries up, and each of them discharges more water than enters through the only visible feeder. The pond covers, say, fifteen acres; it is shallow, with muddy bottom, with boulders in places, the surrounding land being largely made up of granite ledges and boulders. The outlets are at opposite ends of the pond—one descending rapidly 150 feet soon after leaving the pond, the other passing through a boggy swamp and then a meadow, after which it also descends rapidly. The only feeder is very small, and quite dries up in summer."

UNDER the title of "Society for the Publication of Tracts relating to the History and the Geography of the Latin East," an association has been formed in France to supplement the work of the Academy of Inscriptions. Notwithstanding the labours of the latter body, there still exists in the public depositories of various European countries, a large mass of unedited materials relating to the "Latin East,"—the kingdoms of Jerusalem, Cyprus, and Armenia, the principalities of Antioch and Achaia, and the Latin Empire of Constantinople. It is for the purpose of unearthing and publishing such material that the French society has been formed. It will be composed of forty titular members and 350 subscribing associates; from among the former a committee of publication will be selected, and the members of both classes may be either French or foreign. Two volumes will be published annually, along with a phototypographic reproduction of very rare or unique matter; to the latter titular members alone are entitled. The collection will be entitled "Bibliothèque de l'Orient Latin," and will consist of a Historic Series, a Geographical Series, and a Poetical Series. They will be published after the style of the "Chronicles and Memorials of Great Britain." Titular members pay fifty francs a year, and subscribers only fifteen.

THE additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval*) from West Africa, presented by Mr. Spencer Shield; a Cinereous Sea Eagle (*Haliaëtus albicilla*) from Norway, presented by Mr. W. J. Sadler; two Peregrine Falcons (*Falco peregrinus*) from Europe, presented by Mr. Herbert Wood; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. P. T. Wharton; a Crested Pigeon (*Ocyphaps lophotes*), two Graceful Ground Doves (*Geopelia cuneata*), hatched in the Gardens; two Green Fruit Pigeons (*Carpophaga sylvatica*) deposited.

NOTES ON THE NEW EDITION OF MR. DARWIN'S WORK ON THE STRUCTURE AND DISTRIBUTION OF CORAL REEFS (1874.)

MR. DARWIN, in the new and much improved edition of his work on Coral Reefs, mentions some points in the subject, on which he still finds reason to differ from the writer. I think that with regard to one or two of these points he has not fully understood my views; and, as to the others, that the arguments and facts which I have brought out have not received all the consideration they may deserve. A review of some statements in his work may, therefore, be profitable. I follow the order of his criticisms as briefly stated in the first half of his Preface.

I. The second sentence of the Preface is as follows:—

"In this work [Dana's Corals and Coral Reefs] he [the author] justly says that I have not laid sufficient weight on the mean temperature of the sea in determining the distribution of coral reefs; but neither a low temperature nor the presence of mud-banks accounts, as it appears to me, for the absence of coral reefs throughout certain areas; and we must look to some more recondite cause."

The first two clauses of this sentence are true—the *but* between them being removed, as it may lead some readers to suppose the alternative mine. Yet Mr. Darwin's work does not show that even now he appreciates the influence of oceanic temperature on the distribution of coral reefs. In his discussions on the distribution of reefs, and the causes limiting the same, this agency, the chiefest with marine life, both for depth and surface, according to all zoologists, is scarcely mentioned. There is one allusion to the subject on page 81. Mr. Darwin says: "I at first attributed this absence of reefs on the coasts of Peru and of the Galapagos Islands to the coldness of the currents from the south, but the Gulf of Panama is one of the hottest pelagic districts in the world;" and a note is added, giving some sea temperatures of the region referred to. Thus the cause is set aside even for the seas along the Peruvian coast, although the mean winter temperature of the water there is lower than exists in any reef region in the world, and is therefore sufficient of itself to exclude reefs. The fact that there are only small patches at Panama, where the temperature is tropical, does not annul the fact that the seas of Peru and the Galapagos are too cold for corals. Where temperature excludes, there is no use in discussing other unfavourable conditions.

The causes limiting the growth and distribution of reef-making corals and coral reefs, which I have discussed and applied in my work, are *seven* in number:—

(1.) Marine temperature.

(2.) Fresh and impure waters from the entrance of large rivers and muddy bottoms.

(3.) Deposition of sediment borne by rapid tidal currents.

(4.) The depth of water along coasts exceeding 100 feet, that is, exceeding the depth to which reef-corals may grow—a common condition along bold coasts, and often explaining, as I have found, the contrasts between the reef-bordered and open coasts of the same island.

(5.) Exposure to the heat of submarine volcanic eruptions (pp. 299, 317).

(6.) The progressing coral-island subsidence too rapid for the polyps to keep the reef well at the surface, if at all (p. 270): which cause may lead, in atoll seas, to very narrow fringing reefs; to small sizes in coral atolls, and a more or less complete obliteration of the lagoon; and to a submerging of the coral island beneath the surface; or finally, to a complete disappearance of the island (pp. 332, 369).

(7.) The direction and temperature of oceanic currents (p. 112): this cause accounting for the non-distribution of Central Pacific species of corals to the Panama coast, and the paucity of species there, with the absence of the large Astræa group and the Madrepores.

On this last point I say in explanation, on page 112: "Owing to the cold oceanic currents of the eastern border of the Pacific—one of which, that up the South American coast, is so strong and chilling as to push the southern isocryme [the line passing through points of equal mean oceanic temperature for the coldest month of the year] of 68°, the coral sea boundary, even beyond the Galapagos, and north of the equator—the coral-reef sea, just east of Panama, is narrowed to 20°, which is 36° less of width than it has in mid-ocean; and this suggests that these currents, by their temperature, as well as by *their usual westward direction*, have proved an obstacle to the transfer of mid-ocean species to the Panama coast." For the same reason the transfer of corals —warm-water species—from the West Indies or the Bermudas, eastward, to *Western Africa*, is impossible. The width of the coral reef region on the African side of the Atlantic is only 15°, while it is 48° toward the American coast, and the tropical current is *eastward*.

A proper understanding of the action of the various causes influencing the growth and distribution of polyps and reefs, which have been mentioned in the preceding paragraphs, may leave much less than has been imagined for that "more recondite cause."

I did not think to include among the causes a too rapid *upward* change of level—on which Mr. Darwin lays much stress. But I recognised the fact that when a rise, like that which has occurred at the island of Oahu [putting an extended range of reef thirty feet out of water] takes place, and so divides the area of reef into an elevated and non-elevated portion, the latter will be, on this account, narrower than it would have been had the land been stationary. But the cause does not appear to me to have very many examples.

II. The third sentence of the Preface reads thus :—

"Professor Dana also insists that volcanic action prevents the growth of coral reefs much more effectually than I had supposed ; but how the heat or poisonous exhalations from a volcano can affect the whole circumference of a large island is not clear." And this is followed by the remark : "Nor does this fact, if fully established, falsify my generalisation that volcanoes in a state of action are not found within the area of subsidence, whilst they are often present within those of elevation."

In my discussion of this subject I have attributed the destruction here referred to about islands of active, or recently active, volcanoes, not to aërial eruptions, as might be suspected from Mr. Darwin's words, but to *submarine;* and I happen to have said nothing about "exhalations." I have drawn my conclusions especially from four examples (pp. 302, 305, 306) : the island of Hawaii (Sandwich Islands), about which recent eruptions, and partly submarine, have taken place on the east, south-east, south, and west slopes of the island, or through more than half of its circumference ; Savaii, the largest of the Samoan or Navigator Islands, and the last of the group to become extinct, as its lava streams show ; the eastern half of Maui, whose great crater must have been recently in action, while the western half bears the fullest evidence of long extinction ; and the northern extremity of the Ladrones. I state that reefs often occur on favoured parts of even such volcanic islands, as they well might if submarine eruptions were the cause, and I mention examples ; thus agreeing with Mr. Darwin's criticism that "the existence of reefs, though scantily developed, and, according to Dana, confined to one part of Hawaii, shows that recent volcanic action does not prevent their growth." My statement about that Hawaiian reef is worded thus : "the only spot of reef *seen* by us was a submerged patch off the southern cape of Hilo Bay." Mr. Darwin cites an observation with regard to the occurrence also of reefs on the northern coast of Hawaii, which accords precisely with the principle I have laid down, since the northern part of the island is, as I state in my Geological Report of the island, that which was earliest extinct, and is oldest in all its features, and therefore that which would not have been reached by the submarine eruptions. The western peninsula of Maui, or the old part, has its coral reefs, while the eastern, or part recently active, has almost none. Savaii, in like manner, has coral reefs on its western and northern shores, while elsewhere without them.

I failed to find evidence in the case of either of these volcanic regions that they are situated within areas of elevation rather than subsidence. *Only ten miles* west of Savaii lies the large island of Upolu, having very extensive reefs—on some parts of the north side three-fourths of a mile wide ; and it has not seemed safe to conclude that, while Upolu thus bears evidence of no movement or of but little subsidence, Savaii was one of elevation ; or that the north and west sides of Savaii have differed in change of level from the rest of the island. In the island of Maui, having reefs on its old western half, it can hardly be that the eastern peninsula has changed its level quite independently of the western. In the near group of the Ladrones the active volcanoes are at the north end ; the islands of the group are very small at that end, without coral reefs, while large at the other, and with broad reefs. One of them, Assumption Island, near which our Expedition passed, is only a small, steep, cinder cone, the vent of a submerged volcanic mountain. Such facts afford, therefore, some reason for my statement that the Ladrones appear to have undergone their greatest subsidence at the northern extremity of the range ; and no observations yet made suggest the contrary view.

The general proposition, that active volcanoes are absent from areas of subsidence, appears to me to need better proof than it has received. As regards the Pacific Ocean, I have found nothing to sustain it. The subsidence of the coral island area of the ocean was one of so vast extent—the breadth 4,000 miles, according to Mr. Darwin—that the sinking could have been no obstacle to the existence and contemporaneous working of volcanoes.

III. The next point in the Preface is a right correction of a misunderstanding on my part of one of Mr. Darwin's statements. It says : "Professor Dana apparently supposes (p. 320) that I look at fringing reefs as a proof of the recent elevation of the land, but I have expressly stated that such reefs, as a general rule, indicate that the land has either long remained at the same level, or has been recently elevated. Nevertheless, from upraised recent remains having been found in a large number of cases on coasts which are fringed by coral reefs, it appears to me that, of these two alternatives, recent elevation has been much more frequent than a stationary condition."

When my work passes to a second edition, I shall make the needed correction.

But I still hold that, while barrier reefs, as Mr. Darwin urges, are proofs of subsidence, small or fringing reefs are in themselves no certain evidence of a stationary level, and are often evidence of subsidence, even a greater subsidence than is implied by barrier reefs. I have already stated that one cause limiting distribution of reefs is bold shores, a wall of rock of even a hundred and fifty feet producing a complete exclusion. If Tahiti were to subside two thousand feet, it would be an island of precipitous shores all around, and with deep indentations, like the Marquesas, instead of one with broad shore planes. Such bold shores are evidence of subsidence ; and as only very small reefs, if any, could find footing about such an island, the narrow reef would be another consequence of the subsidence, and no evidence of a stationary condition. Again, the gradual sinking of an atoll, like the Gambier group, or of a Tahiti with its barrier reefs, at a rate a little fast for the growing corals, would necessarily contract the reef region, reduce the barrier reefs of a Tahiti to narrow fringing reefs ; and make an atoll, however large, a small atoll with the reef-border narrow and the lagoon perhaps obliterated. An atoll thus reduced to a sand-bank is an example of the effects of subsidence, and affords no evidence of elevation or of a long stationary condition of the region : and the same may be true of a region of narrow fringing reefs. I landed on two of the small coral islands of the equatorial Pacific which are in just the condition here described ; and my book contains descriptions of others from a good observer—J. D. Hague—who resided on them several months "for the purpose of studying the character and formation of the guano deposits."* I found the depression of the old lagoon, in one case partly, in the other wholly, dry ; and I found also that the living reefs around were narrow. Mr. Darwin inclines to regard islands of this kind as either evidence of no movement, or, of elevation. On the contrary, since the coral islands of the South Pacific diminish in size toward the region of these small islands, and since the region just beyond, to the north and north-east, is free from islands, and since all the features are such as would come to them from a continuation of the coral-island subsidence to its nearly fatal end, I believe still that I was right in considering the ocean bottom in this part to have undergone a general subsidence greater than that to the south, south-west, and west, where the atolls and barrier reefs are large.

Again, if submarine eruptions are destructive, narrow reefs may exist about volcanic islands that are undergoing a subsidence. Making a reef is slow work ; and, judging from the eruptions of the present century about Hawaii, reefs would have had a poor chance in the past to form, except along the coasts that were out of reach of the submarine action.

With so many causes for the existence of narrow or fringing reefs, or of small patches of corals, it is assuredly unsafe to make them, without other corroborating testimony, evidence of a stationary condition of a region, or of an elevating movement rather than a subsiding.

IV. The next point in the Preface is stated as follows :—

* His article is contained in the *American Journal of Science*, 2nd series, xxxiv. 224 ; 1862.

"Prof. Dana further believes that many of the lagoon islands in the Paumotu or Low Archipelago and elsewhere have recently been elevated to a height of a few feet [elsewhere stated, two or three feet] although formed during a period of subsidence; but I shall endeavour to show, in the sixth chapter of the present edition, that lagoon islands which have long remained at a stationary level often present the false appearance of having been slightly elevated." And, in the body of the work, where the subject is taken up (p. 168), Mr. Darwin remarks that my belief in these small local elevations is grounded chiefly on the shells of Tridacnas embedded, in their living positions, in the coral rock at heights where they could not now survive.

The catalogue of such elevations which I give (p. 345)—after a dozen pages devoted to a discussion of the evidence respecting each—is as follows:—

Paumotu Archipelago	Honden	2 or 3
,, ,,	Clermont Tonnerre	2 or 3
,, ,,	Nairsa or Dean's	6
,, ,,	Elizabeth	80
,, ,,	Metia or Aurora	250
,, ,,	Ducie's	1 or 2?
Tahitian Group	Tahiti	0?
,, ,,	Bolabola	?
Hervey and Rurutu Groups	Atiu	12?
,, ,, ,,	Mauke	somewhat elevated.
,, ,, ,,	Mitiaro	,, ,,
,, ,, ,,	Mangaia	300
,, ,, ,,	Rurutu	150
,, ,, ,,	Remaining Islands	0?
Tongan Group	Eua	300?
,, ,,	Tongatabu	50 to 60
,, ,,	Namuka and the Hapaii	25
,, ,,	Vavau	100
Savage Island		100
Samoan or Navigator Islands		0
North of Samoa	Swain's	2 or 3
,, ,,	Fakaafo, or Bowditch	3
,, ,,	Oatafu, or Duke of York's	2 or 3
Scattered Equatorial Islands	Washington	2 or 3?
,, ,, ,,	Christmas	?
,, ,, ,,	Jarvis's	8 or 10
,, ,, ,,	Malden's	25 or 30
,, ,, ,,	Starbuck's	?
,, ,, ,,	Penrhyn's	35
,, ,, ,,	Flint's and Staver's	?
,, ,, ,,	Baker's	5 or 6
,, ,, ,,	Howland's	?
,, ,, ,,	Phœnix and McKean's	0
,, ,, ,,	Enderbury's	2 or 3?
,, ,, ,,	Newmarket	6 or 8?
,, ,, ,,	Gardner's, Hull's, Sydney, Birnie's	0?
Feejee Islands	Viti Levu and Vanua Levu, Ovalau	5 or 6?
	Eastern Islands	0?
North of Feejees	Horne, Wallis, Ellice, Depeyster	0?
Sandwich Islands	Kauai	1 or 2
,, ,,	Oahu	25 or 30
,, ,,	Molokai	300
,, ,,	Maui	12
Gilbert Islands	Taputeuea	2 or 3
,, ,,	Nonouti, Kuria, Maiana, and Tarawa	3 or more.
,, ,,	Apamama	5
,, ,,	Apaiang or Charlotte.	6 or 7
,, ,,	Marakei	3 or more.
,, ,,	Makin	?
Carolines	McAskill's	60
Ladrones	Guam	600
,,	Rota	600
Feis		90
Pelews		0?
New Hebrides, New Caledonia, Salomon Islands		none ascertained.

Of the cases of elevation here included, in *only two* are shells of Tridacnas mentioned; these are Honden Island and Clermont Tonnerre, in the Paumotus. It is not necessary to go over the evidence for the several cases, as it is stated at length in my work.

Mr. Darwin, while speaking on the subject of local elevations, on p. 176, and discussing the facts as regards the Samoan (Navigator) Islands, adds that "in another place he [Mr. Dana] says (p. 326) that some of the [Samoan] islands have probably subsided." From the remark the reader would infer that this Samoan subsidence was a local subsidence, like the elevations under consideration. But in fact my statement is in a chapter on the general coral-island subsidence, and, on the page there referred to (p. 326), I cite Mr. Darwin's conclusions as to the Gambier Island subsidence, and put with it my own from the width of the reefs of Upolu and other reef-bordered islands. At the same place I allude to the greater subsidence of Tutuila—the island next to the west, as proved by its bold shores and small reefs.

In conclusion, if I differ widely, for the reasons above stated, from Mr. Darwin, as to the limits of the areas of subsidence and elevation in the Pacific, and believe that the new edition of his work shows little appreciation of some of the most important causes that have limited the distribution of coral reefs, I have, as I say in my work, the fullest satisfaction in his theory for the origin of atoll and barrier forms of reefs, and in the array of facts of his own observation which illustrate the growth of coral formations.

JAMES D. DANA

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee on the Teaching of Physics in Schools, by Prof. G. C. Foster.

In view of the very great diversities in almost all respects of the conditions under which the work of different schools has to be carried on, the committee considered that in any suggestions or recommendations that they might make it would be impossible for them, with any advantage, to attempt to enter into details. They have therefore, in the recommendations which they have agreed upon, endeavoured to keep in view certain principles which they regard as of fundamental importance, without attempting to prescribe any particular way of carrying them out in practice.

They have assumed as a point not requiring further discussion, that the object to be attained by introducing the teaching of physics into general school-work is the mental training and discipline which pupils acquire through studying the methods whereby the conclusions of physical science have been established. They are however of opinion that the first and one of the most serious obstacles in the way of the successful teaching of the subject is the absence from the pupil's mind of a firm and clear grasp of the concrete facts and phenomena forming the basis of the reasoning processes they are called upon to study.

They therefore think it of the utmost importance that the first teaching of all branches of physics should be, as far as possible, of an experimental kind. Whenever circumstances admit of it, the experiments should be made by the pupils themselves and not merely by the teacher, and though it may not be needful for every pupil to go through every experiment, the committee think it essential that every pupil should at least make some experiments himself. For the same reasons they consider that the study of text-books should be entirely subordinate to attendance at experimental demonstrations or lectures, in order that the pupil's first impressions may be got directly from the things themselves, and not from what is said about them. They do not suppose that it is possible in elementary teaching entirely to do without the use of text-books, but they think they ought to be used for reviewing the matter of previous experimental lessons rather than in preparing for such lessons that are to follow.

With regard to the order in which the different branches of physics can be discussed with greatest advantage, considering that all explanation of physical phenomena consists in the reference of them to mechanical causes, and that therefore all reasoning about such phenomena leads directly to the discussion of mechanical principles, the committee are of opinion that it is desirable that the school teaching of physics should begin with a course of elementary mechanics, including hydrostatics and pneumatics, treated from a purely experimental point of view. The committee do not overlook the fact that very little progress can be made in theoretical mechanics without considerable familiarity with the processes of mathematics, but they believe that by making constant appeal to experimental proofs the study of mechanics may be profitably begun by boys who have acquired a fair knowledge of arithmetic, including decimals and proportion, and as much geometry as is equivalent to the first book of Euclid. They believe that it will be found sufficient to impart such further geometrical knowledge as may be required, such, for instance, as a knowledge of the properties of similar triangles—in the first instance, during the course of instruction in mechanics.

In reference to the order in which the other departments of physics should be studied, the committee do not think it possible to prescribe any one order that is necessarily preferable to others that might be adopted; but they consider it desirable that priority should be given to those branches in which the ideas encountered at the outset of the study are most easily apprehended, and illustrations of which are most frequently met with in common experience. On these grounds they suggest that the elementary parts of the science of heat may advantageously follow mechanics; that elementary optics (including the laws of reflexion and refraction, the formation of images, colour, chromatic dispersion, and the construction of the simple optical instruments) should come next, and afterwards the elements of electricity and magnetism.* When it is found possible to include in the work of a school a fuller or more advanced course of physics than that here indicated, the committee are of opinion that the discretion of the master, guided by the circumstances of the case, will best decide in what direction the extension shall take place; they suggest, however, that an early place in the course should be given to elementary astronomy, both because it furnishes the grandest and most perfect examples of the application of dynamical principles, and because it promotes an intelligent interest in phenomena which, in the most superficial aspects at least, cannot fail to arrest the attention and familiarise the mind with the wide range of application of physical laws.

The committee are strongly of opinion that no very beneficial results can be looked for from the general introduction of physics into school teaching, unless those who undertake to teach it have themselves made it the subject of serious and continued study and have also given special attention to the best methods of imparting instruction in it. They therefore suggest that with a view to affording facilities to persons desirous of becoming teachers of physics for familiarising themselves with the most efficient methods and gaining experience in them, the Council of the British Association should invite the leading teachers of physics in the universities, colleges, and schools of the United Kingdom, to allow such persons, under suitable regulation, to be present at the instructions given by them, and, when practicable, to act as temporary assistants. The committee do not hereby mean that aspirants to the teaching function should be encouraged to drop in at random to hear any lecture by any established teacher who happened to be within reach; the kind of attendance they have in view would be systematic and continued for not less than some moderate period of time, such perhaps as two or three months, agreed upon at starting.

They believe that the benefits which might result from the adoption of such a plan are very great; the advantages to those who might avail themselves of it are obvious, and while teachers of established success would have a chance of spreading widely their methods of instruction, and in fact of founding schools of discipline, the stimulus to exertion afforded by the consciousness that they were being watched by men who were preparing themselves to occupy positions similar to their own would be of the most efficient kind.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS

On the application of Kirchhoff's Rules for Electric Circuits to the solution of a Geometrical Problem, by Prof. Clerk-Maxwell, F.R.S.

The geometrical problem is as follows:—Let it be required to arrange a system of points so that the straight lines joining them into rows and columns shall form a network such that the sum of the squares of all these joining lines shall be a minimum, the first and last points of the first and last row being any four points given in space. The network may be regarded as a kind of extensible surface, each thread of which has a tension in each segment proportioned to the length of the segment. The problem is thus expressed as a statical problem, but the direct solution would involve the consideration of a large number of unknown quantities.

* It should be stated that one member of the committee did not approve of the order of the subjects suggested in the text.

This number may be greatly reduced by means of the analogy between this problem and the electrical problem of determining the currents and potentials in the case of a network of wire having square meshes, one corner of which is kept at a unit potential, while that of the other three corners is zero. This problem having been solved by Kirchhoff's method, the position of any point P in the geometrical problem with reference to the given points A B C D, is by finding the values of the potentials p_a p_b p_c p_d of the corresponding point in the electric problem when the corners a b c d respectively are those of unit potential. The position of P is then found by supposing p_a p_b p_c p_d placed at A B C D respectively, and determining P as the centre of gravity of the four masses.

On the Apparent Connection between Sun-spot and Atmospheric Ozone, by T. Moffat, M.D., F.G.S., &c.

At the last meeting of the British Association, Mr. Smith, of Birmingham, gave me a record of the number of new groups of sun-spots which appeared in each year for a number of years, and he asked me to compare the mean daily quantity of ozone in each year with the number of groups. I have done so, and in the following table I have given the mean daily quantity of ozone for nineteen years (1851-1869) with the number of groups.

Years.	Total number of new groups of spots which have appeared in each year.	Mean daily quantity of ozone.	Maximum actual number of groups.	Mean of ozone.
1851	141	2·6	141	2·6
1852	125	1·9	125	1·9
1853	91	2·0	202	1·5
1854	67	3·4	205	2·2
1855	28	·8	211	2·1
1856	34	·7	204	1·9
1857	92	1·1	166	2·6
1858	202	1·5	124	3·5
1859	205	2·2	130	2·0
1860	211	2·1	101	1·7
1861	204	1·9	224	1·9
			Mean, 166	Mean, 2·2
			Minimum.	Mean of ozone.
1862	166	2·6	91	2·0
1863	124	3·5	67	3·4
1864	130	2·0	28	·8
1865	93	2·4	34	·7
1866	45	1·7	98	1·1
1867	25	1·5	93	2·4
1868	101	1·7	45	1·7
1869	224	1·9	25	1·5
			Mean, 60	Mean, 1·7

It would appear from these figures that the maximum of sun-spot gives a maximum of ozone, and that the minimum of sun-spot gives the minimum of ozone. The years 1854 and 1863 appear to be exceptional. In 1854, however, ozone observations at Hawarden were suspended for three months, which may account for the irregularity in that year. There is, I think, in these results, sufficient to induce others to observe.

On the employment of Charts on Gnomonic Projection for the general purposes of Navigation, by G. J. Morrison.

The object of this paper is to recommend the adoption for the general purposes of navigation of charts on gnomonic projection, instead of on Mercator's projection, for the following reasons:—

1. The great circle course or shortest distance between any two points on the earth's surface is shown by a straight line on the chart. By means of a ruler, therefore, it is easy to find out in one moment the position of the great circle track along the whole course from point to point, and thus to see at a glance if there be any obstacles in the way, whereas the plotting of a great circle track on a Mercator chart involves the expenditure of a great deal of time and trouble.

2. When it is impossible to adopt the great circle course on account of obstacles in the way, it is easy, in a few moments, to lay down the best practicable course, whereas it is very difficult to do so on a Mercator chart.

3. The measurement of distances on a Mercator chart is somewhat difficult, whereas on these maps distances can be measured with a transparent scale, or a pair of compasses, in a few moments.

4. The relative position of the various points on the earth's surface is more correctly shown on these maps than on those of Mercator.

The great circle course appears to be the shortest and natural route, whereas, on an ordinary chart, it appears to be much longer than the Mercator route, and seamen get a bettter idea from these charts of the proper route to follow than they do from a Mercator's chart.

1. It may be objected that only a small portion of the earth can be got on one sheet, and there is a difficulty in drawing a great circle course between points situated on separate sheets. This is true; but by taking some pains in arranging the maps, as has been done in this case, and by repeating portions of the earth on two or more sheets, matters have been so arranged that scarcely any voyage can be named in which the ports of arrival and departure cannot be found either on the same sheet or on opposite sheets, in either of which cases the course can be laid down instantly; and even in the rare case of two ports being found on adjacent sheets only, the course can be laid down infinitely more easily than on a Mercator chart.

2. It is impossible to find the bearing of one point from another as can be done on a Mercator chart by a compass and a parallel ruler. This really is no disadvantage; no one ought to sail along a curved course, and no one need care to know anything about such a course. If this objection be seriously urged, it only proves that Mercator's charts have put false ideas into people's heads, and that other charts are required to replace them.

SECTION C—Geology

On the discovery of Microzoa in the Chalk Flints of the North of Ireland, by Joseph Wright.

The author observed that until 1872 only one rhizopod had been found in the Cretaceous rocks of Ireland, viz., *Ortitolina concava*, recorded by Mr. R. Tate, as occurring in the greensand. In November 1872, Prof. Rupert Jones read a paper before the Geological Society of Ireland, in which he announced the discovery of nine species of Foraminifera in the chalk and chalk flints of the North of Ireland.

Mr. Wright has examined the soft powdery material which often lines cavities in the chalk flints of Ireland, and has found 69 species of Foraminifera, 11 of Ostracoda, and sponge-spicules in abundance. A full list will appear as an appendix to the next Report of the Belfast Naturalists' Field Club.

Some observations on the "paramoudras" were added. The author considers that these originated in most cases by the deposit of flint around a nucleus of sponge. A microscopic examination shows that some are charged with spicules, whilst others are nearly free from them.

Prof. H. A. Nicholson exhibited and described specimens of three new species of *Cystiphyllum* from the Corniferous limestone of Canada and Ohio. Of these, *C. Ohioense*, Nich., is distinguished by its small size, deep, pointed calice, and small number of septa; *C. squamosum*, Nich., is remarkably flattened, the calice being very shallow and oblique; *C. fructicosum*, Nich., is a compound form, composed of numerous cylindrical, straight or slightly flexuous corallites.

The next paper, by the same author, was devoted to the definition of several species from the Lower Silurian of Ohio. *Alecto inflata* of Hall was regarded as an undoubted *Hippothoa*.

Description of new species of Polyzoa from the Lower and Upper Silurian rocks of North America, by Prof. H. A. Nicholson.—In this communication the author described the following new species of Polyzoa:—1. *Ptilodictya falciformis*, Nich.; 2. *P. emacerata*, Nich.; 3. *P. flagellum*, Nich.; 4. *P. ? arctipora*, Nich.; 5. *P. fenestelliformis*, Nich.; 6. *Fenestella nervata*, Nich. 7. *Ceramopora Ohioensis*, Nich.

Prof. Nicholson also read a paper on species *Favistella*. The type of the genus *F. stellata*, Hall, he regarded as identical with Goldfuss' *Columnaria alveolata*. A new species *Favistella* (*Columnaria*) *calicina*, Nich., was described.

These papers were illustrated by numerous and beautiful examples of the species referred to.

Note on the so-called "Crag" bed of Bridlington, by J. Gwyn Jeffreys, F.R.S.

In consequence of a request made by the late Prof. Phillips, not long before his lamented death, the author examined all the known collections of fossil shells from the celebrated "Crag" beds at Bridlington, and had furnished the Professor with a *catalogue raisonnée* for the new and forthcoming edition of his work on the Geology of Yorkshire. Dr. Jeffreys was lately at Bridlington with Mr. Leckenby, and ascertained that the "Crag" bed underlay the boulder-clay, and rested conformably on a bed of oolite shale of a purplish colour, which in one place appeared to have been triturated and redeposited in the form of clay. In this purplish clay they found a specimen of *Turritella erosa*, Couthouy (an arctic and North American shell), besides many other species which were common to the boulder-clay and Bridlington bed. All the species of shells found in the Bridlington bed, 64 in number, were high northern and now living. The author suggested that this deposit of shells might have been caused either by a deviation of the great arctic current in ancient times or by glacial conditions. It had clearly no relation to the Norwich Crag, as was formerly imagined to be the case.

SECTION D—Biology

Department of Anatomy and Physiology

This department was not distinguished by any communication which excited such popular interest as that of Prof. Ferrier last year, but it was fully up to the average of the last few meetings in the solidity of the papers and of the discussions. The President, Prof. Redfern, opened the Section with the address printed in full in Nature, vol. x. p. 327, which was no less admirable in style and elocution than in matter. If this was a model of a professorial lecture, the address of Dr. Hooker, also delivered before the entire Section, was equally one of a popular exposition of new and difficult scientific observations. The excellent series of illustrations and the actual specimens of the plants described, which were sent by Dr. Moore from the houses of the beautiful Botanical Gardens in Dublin, completed the interest of this admirable address.

The only report made to the department was from the committee appointed to investigate the conditions of intestinal secretion. It contained details of about sixty experiments, which confirmed, in the case of cats, Moreau's observation of the effect of division of the mesenteric nerves, showed that the secretory nerve fibres did not pass through the splanchnics, and ascertained the local effect of various neutral salts on intestinal secretion, as well as the interference of chloral, morphia, and other drugs with the local action of magnesian sulphate. The committee* was reappointed for the present year to continue these researches on the secretion and the movements of the intestines.

The most important communication on the first day was from Prof. Cleland, *On the Development of the Brain and the Morphology of the Auditory Capsule.* Beside many characteristically ingenious suggestions, the author maintained that the fourth ventricle is roofed in by nervous matter at an early period in the embryo, of which the ligula and the choroid plexus are the permanent vestiges. He also attempted to draw a parallel between the flocculus with the portio mollis and the optic lobes, tracts, and nerves. Prof. Huxley criticised these views at some length, dwelling particularly on the comparatively late development of the optic tracts, and denying that the roof of the primitive nervous canal is ever completed in the region of the bulb. A certain Goodsirian transcendentalism which appeared in Prof. Cleland's remarks has become rare among the younger school of morphologists, and probably stimulated his critic to attack what must have seemed like the revival of a thrice-slain foe; but apart from interpretations and views, there were several important observations in the paper which, it is hoped, will be given in detail with the necessary drawings.

A paper by Mr. Thomson followed, *On the Decomposition of Eggs*, in which the purely chemical changes, the penetration of bacteria, and the growth of fungi were severally described;† and Dr. Macalister exhibited a human skull with the rare abnormality of a lacrymo-jugal suture.

After the crowded audience which listened to Dr. Hooker's

* Dr. Brunton and Dr. Pye Smith.

† This paper will be found reported in the *London Medical Record* for Sept. 9.

address on Friday had dispersed, it seemed as if the room would have been left to anatomists and physiologists; but the arrival of blacksmiths, who began to erect a large black canvas, attracted popular interest, and the visitors who flocked in were rewarded by hearing and seeing Mr. Waterhouse Hawkins discuss the true character of the so-called clavicles of Iguanodon. His account of the difficulty he experienced in building his model with these bones in the position at first assigned them by Prof. Owen, of his finally hanging them up in front of it to be fitted in after each spectator's taste, and of the shameful destruction of the results of his skill and labour at New York, was no less graphic than the illustrations with which he proceeded to cover the canvas, showing the great reptile in every posture which would consist with the disputed bones being clavicles, ossa pubis, or marsupial bones. Mr. Hawkins advocated the last as the true character; but though in the discussion which followed, some anatomists were disposed to admit this approximation of the highest of reptiles to the marsupial (or rather to the monotreme) mammals, others refused to admit any reason for rejecting the identification of the bones in dispute with the long bird-like ossa pubis of allied reptilian forms, which was made several years ago by Prof. Huxley. So at least the professor himself must have thought, for he only appeared at the conclusion of the discussion in time to hear Mr. Balfour's remarkable paper *On the Development of Sharks*. This will doubtless appear elsewhere in full. It was crowded with facts, well observed, well stated, and well illustrated; and will prove of first-rate importance, not only for ichthyology but for the general doctrines of vertebrate development. Of many new facts ascertained, perhaps the most startling is the development of the notochord by direct cellular proliferation from the hypoblast. Whether it will ultimately be found that this is its normal mode of formation among Vertebrata, or that it may be developed from different layers in different animals, the effect of this observation will be almost equally important. Those anatomists who examined the beautiful series of sections on which Mr. Balfour founded his conclusions were satisfied of the accuracy of his histological facts. Prof. Huxley congratulated the author of the paper in terms of high commendation, though he inclined to believe that the apparent development from the lower embryonic layer might really be a secondary process. Mr. Lankester and Dr. Foster spoke of the service rendered to biology by Dr. Dohrn's Institute at Naples, where Mr. Balfour's observations were made, an institute to the success of which the British Association had the honour to contribute.

The following paper by Prof. Redfern, *On Food in Plants and Animals*, has been well reported in the *British Medical Journal* for August 29, p. 285. It was illustrated by a striking series of specimens of plants growing on different soils, and the laws of nutrition in organised beings generally were applied with great force to the practical question of the food of the labouring classes in the north of Ireland. Well delivered, and clearly expressed, it appeared to be understood as well as applauded by a full audience.

The first paper read in the department on Monday was by Prof. Macalister, *On the Tongue of the Great Anteater*, including an account of its enormous retractile muscles and of the salivary glands. In a discussion which followed, reference was made to the original dissection of *Myrmecophaga* by Prof. Owen, and also to the observations of Mr. Flower on the same parts, of which a summary was published in the *Medical Times and Gazette* of last year.

The next paper, by Dean Byrne, was an attempt to connect the functional development of thought with the structural development of the brain, in their gradual evolution throughout the Vertebrata, as well as in their growth from the infant to the adult. Many interesting facts of animal psychology were related, and many acute comments offered, but unfortunately the works from which the author drew his facts of anatomy, pathology, and development were either antiquated or otherwise imperfect representations of the present state of knowledge on the points in question.

Though the paper which followed was also by an outsider, the Professor of Chemistry in Edinburgh has had the advantage of a medical training, and his anatomy and histology were as accurate as his physics. Nothing could be more interesting than the way in which Dr. Crum Brown described the methods he employed to ascertain the exact position of the semi-circular canals of the ear, and the experiments he made on the sense of rotation. The substance of the communication will be found in the last number of the *Journal of Anatomy and Physiology*. Notwithstanding some criticisms offered by Mr. Charles Brooke on the acoustics of the paper, both its anatomical facts and its conclusion as to the function of the canals appeared to find general acquiescence; and this research may be regarded as another proof of how rich a field lies on the border-ground between the artificial territories into which we have divided the world of science.

Before the department rose, Dr. Caton exhibited a new adaptation of a microscope on the Hartnack model, for the purpose of examining the tissues in living mammals. It was a cheaper, and, as the author believed, a more readily applicable modification of the apparatus exhibited by Professors Stricker and Sanderson, at the Edinburgh meeting of the Association.

Prof. Huxley opened the last day of session with an account of his recent observations on the development of the *Columella auris* in Amphibia. While fully confirming the position of the quadratum (or malleus) in the mandibular arch of vertebrates, and of the incus in the hyoidean, these investigations appear to show conclusively that in the amphibian, at least, the columella (or stapes) begins as an outgrowth from the periotic capsule, and is therefore unconnected with any visceral arch; although, as the speaker was careful to state, it might yet be possible that the hyoid arch had, at a very early period, left some of the tissue of its topmost extremity adherent to the ear-capsule, and that this might afterwards give rise to the stapes. In the absence of Mr. Parker there was no one competent to criticise the paper from personal knowledge; but a word dropped as to the many changes in the accepted homologies of the ossicula auditus, elicited a masterly and characteristic exposition of the series of new facts, and the modifications of theory they have led to, from Reichert's first observations down to the present time. The embryonic structures grew and shaped themselves on the board, and shifted their relations in accordance with the views of successive observers, until a graphic epitome of the progress of knowledge on the subject was completed.

Mr. Lankester's paper which followed was also embryological. He described his observations on the development of the eye of Cephalopoda, made like those of Mr. Balfour in the Dohrn Institute at Naples. After correcting several of the statements made in text-books on the authority of Prof. Kölliker, the author pointed out the relation of the eye in the Dibranchiata to the less specialised organ of Nautilus, and showed how the ontogenesis of this structure in the highest mollusk corresponds with its gradually increasing complexity from its first appearance in the group, thus meeting one of Mr. Mivart's objections.

The session was appropriately concluded by a paper from the President, describing experiments made several years ago on the effects of ozone. The animals used were rabbits, and Prof. Redfern found them much less injuriously affected by breathing highly oxygenated air than has been supposed, while ozone in moderate amount (·4 per cent. and upwards) proved rapidly fatal, producing spasms, and death by apnœa. The lungs were found extensively emphysematous and congested, with engorgement of the right side of the heart.

Thus ended a busy and not uneventful meeting of the department. Comparing it with recent years, the room was never so crowded as it sometimes was at Bradford, nor so empty as it usually was at Brighton and Edinburgh. The most important paper last year, that of Prof. Burdon-Sanderson on the electrical changes which accompany the contraction of Dionæa, excited little popular interest, and the discussions at Edinburgh on various points of Cetacean anatomy, though carried on by Turner, Flower, Macalister, Struthers, and Murie, were caviare to the general. This year a corresponding importance may be fairly assigned to the embryological papers contributed by Prof. Huxley, Mr. Ray Lankester, Mr. Balfour, and Prof. Cleland. With a fair proportion of more popular expositions, the solid contributions which have been made during the last five or six years should attract a more constant attendance of anatomists and physiologists to this department. There were several distinguished Irish members of the Association whose presence was greatly missed at Belfast; and considering its nearness to Scotland, there was a remarkable lack of representatives from the northern universities. Apart from the intrinsic value of the papers read, there is so much to be gained from personal contact and discussion with men working at the same objects, that few probably feel at the conclusion of a meeting that they have not been rewarded for the sacrifice of time and convenience, and the scientific value of the Association entirely depends on its power of attracting those who are seriously engaged in the prosecution or communication of the subjects which form its several branches.

SCIENTIFIC SERIALS

Geological Magazine, September.—This number contains four original articles :—(1) The grouping of the Permian and Triassic rocks, by H. B. Woodward, F.G.S. The object is to show that the supposed break between the subdivisions of the Triassic rocks in England rests on unsatisfactory evidence; that in the Permian beds there are evidences of unconformity; and that probably future researches will lead to the resumption of the term "Poikilitic" to embrace both the Permian and Trias.—(2) On the Pleistocene deposits yielding Mammalian remains in the vicinity of Ilford, Essex, by Messrs. Woodward and Davis. This article consists partly of references to previous numbers of the magazine, the chief feature of interest in it being a letter by Mr. Searles Wood. He formerly believed the Ilford brick earths were older than the main sheet of the Thames gravel; a view which he now corrects.—(3) On the remains of *Rhinoceros leptorhinus*, Owen, from the Pleistocene of Ilford, by the editor. This is a reprint of Mr. Davis's description of the skull, as given in Sir Antonio Brady's catalogue (privately printed), together with an extract from Dr. Falconer's palæontological memoirs.—(4) On West Indian Tertiary Fossils, by R. J. Lechmere Guppy; a first instalment of descriptions which are to be continued.—Mr. J. W. Barkas, in a letter, announces that he has found a jaw of *Amphicentrum*, in sub-carboniferous limestone near Richmond, and suggests that it must have lived both in fresh and salt waters, like some modern fishes.

Astronomische Nachrichten, No. 2,005.—L. Seidel contributes a paper on the estimation of the most probable value of a number of varying observations of the same phenomenon, as the value of a number of observations of the position of a double star. There are also a quantity of position observations on Coggia's comet, by C. H. Davis, Ant. Aguilar, and Alexander Gromadzki, and the following elements of this comet are found by W. Fabritius:—

$$T = \text{July } 8{\cdot}90006$$
$$\text{Log. } q = 9{\cdot}829699$$
$$\Omega = 118^\circ\ 44'\ 9''{\cdot}6$$
$$i = 66^\circ\ 23'\ 1''{\cdot}0$$
$$\omega = 152^\circ\ 21'\ 42''{\cdot}4$$

The opposition ephemeris of the planet Hecate (100) is contributed by Dr. J. E. Stark for each day from Sept. 17 to Oct. 27.—Prof. Spoerer sends a table of his observations on solar spots and protuberances for June. Capt. Herschel writes to ask for letters of Sir J. Herschel, stating that a collection is being made.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, Sept. 7.—M. Frémy in the chair.—M. Resal presented the Academy with the second volume of his "Traité de Mécanique Générale," and made some remarks thereon.—M. P. Volpicelli addressed a letter to the president, stating that in 1854 Melloni had communicated a note to the Academy, entitled "Researches on Electrostatic Induction." Fifteen days afterwards the Italian physicist died of cholera at Naples, and since that time the author (M. Volpicelli) had submitted fifteen communications to the Academy on the same subject, all of which confirmed Melloni's theory of electrostatic induction. M. Volpicelli now begs the Academy to appoint a commission to report on these experiments, and expresses a hope of being permitted to repeat them before it. MM. Becquerel, Faye, Frémy, Edm. Becquerel, and Jamin were named commissioners.—Sixth note on the electric conductivity of ligneous bodies, by M. Th. du Moncel.—Presence of zircosyenite in the Canary Isles, by M. Stan. Meunier. The mineral was found in a collection made by M. Webb on the Pena Mountains.—On some laboratory experiments concerning the action of toxic gases on *Phylloxera*; actual state of the malady in the Charente provinces; extract from a letter from M. Maurice Girard to M. Dumas. The gas tried was that liberated from a sulphocarbonate. Pieces of brick saturated with the solution of the salt were placed in the bottoms of flasks; above the solution and saturated brick some strong paper was supported on which were placed phylloxerised roots. The roots thus escaped direct contact with the solution and received only the gases evolved (CS_2 and H_2S). At the end of twenty-four hours nearly all the insects were dead, with the exception of some small larvæ and some eggs; at the end of two days all the insects and the greater part of the eggs were dead; while at the end of four days complete death of the eggs took place. During the experiment the flasks were kept in the dark, and some control flasks containing phylloxerised roots only placed with the others: nearly all the insects and eggs survived in these last flasks.—On some new points in the natural history of *Phylloxera vastatrix*; a letter from M. Lichtenstein to M. Dumas. The author thus sums up the life history of the insect so far as at present known:—(1) Colonising females appearing probably in August and September; (2) small uniform progeny hybernating; (3) Oval, pyriform, testudiniform types, reproducing by parthenogenesis all the summer; (4) Pupæ of two forms, oval and narrow at the waist, specially found on the nodosities of the rootlets in June and July; (5) *Swarming* takes place in August: the insects emerge from the earth in myriads exactly as in a formicary when the winged insects escape; (6) Laying of eggs on the leaves of *Quercus coccifera*, end of August; (7) Birth of sexual apterous individuals. Copulation and production of colonising females.—On some processses for destroying *Oïdium* and *Phylloxera*; extract from a letter from M. Desforges to M. Dumas.—Employment of the lime from gas purifiers to check *Phylloxera*; extract from a letter from M. L. Petit to M. Dumas.—Observation of an extraordinary passage of corpuscles across the sun; a telegram from M. Gruey, of the Toulouse Observatory, to the president. The passage took place on the 5th, 6th, and 7th of the present month.—On some applications of Abel's theorem relating to elliptic functions to curves of the second degree, by M. H. Léauté.—Note on magnetism, by M. F. M. Gaugain; a continuation of former researches.—Note on the nature of the sulphurising compound mineralising the thermal waters of the Pyrenees, by M. E. Filhol.—Note on chlorophyll, by M. E. Filhol. The chlorophyll of monocotyledons (Graminæ, Cyperaceæ, Liliaceæ, &c.) treated with a small quantity of hydrochloric acid becomes turbid, and the solution, on filtration, leaves a black crystalline compound on the filter. This substance has been examined in some detail. It is remarkable that a solution of chlorophyll from dicotyledons yields, under the same treatment, a dark compound which is amorphous.—On some phenomena of localisation of mineral and organic substances in Mollusca, Gasteropoda, and Cephalopoda, by M. E. Heckel. Specimens of *Helix aspersa* and *Zonites algirus* were fed with white lead, or with acetate of lead mixed with wheat flour. An accumulation of metal was found in the liver and also in the cerebral ganglia. *Loligo vulgaris*, *Sepia officinalis*, and *Octopus vulgaris* were fed during two months with garancine (mixed with meat). In no case was the internal shell coloured, but the cephalic cartilage and all the cartilaginous portions of the skeleton of these Mollusca were coloured after an experiment of three months' duration. The author points out the necessity of distinguishing clearly the hard parts belonging to the skeleton from those belonging to the shell.—On the storm of the night of 1st to the 2nd of Sept. 1874, observed at Versailles; a note by M. Ad. Berigny. 17·59 mm. of rain fell during the storm, and the lightning struck four points in Versailles.

CONTENTS

Erratum.—P. 379, col. 2, line 8 from bottom, for *or* read *on*.