THURSDAY, OCTOBER 10, 1872

HOUZEAU ON THE FACULTIES OF MAN AND ANIMALS

Etudes sur les Facultés Mentales des Animaux comparées à celles de l'Homme. Par J. C. Houzeau, Membre de l'Académie de Belgique. 2 vols. pp. 1,008. (Paris: Hachette, 1872. London: Williams and Norgate.)

IF this work had appeared a few years ago it would have created for its author a considerable reputation. Even now, had it been written in Europe after a careful study of all the best authorities on the subject, it might have been made a very valuable and important treatise. But its author tells us—and the fact is clearly reflected in its pages—that it has been mainly written during a residence in the less cultivated parts of America, without the means of consulting the more recent works on the various subjects of which it treats. It is true that M. Houzeau is a close and acute observer of the habits of animals, and he has furnished us with many curious and original facts; but his own observations and experiments are so overlaid by vast masses of less trustworthy and often irrelevant matter, and are so widely scattered owing to his elaborate classification and minute sub-division of the subject, that they lose much of their force and impressiveness.

For a work written under the circumstances here stated, it is far too large and too pretentious. It aims at an exhaustive treatment of the whole series of the actions and passions of animals and of man, as illustrating their comparative mental nature. It treats in detail of each sense, each habit, each instinct, each custom, passion, and idea; and it discusses so fully the phenomena of language and society that the title should have been reversed, it being really a study of the mental faculties of Man as compared with those of Animals.

The subject of inquiry, as stated by the author, is, "whether the mental faculties of man, of which our arts, sciences, and social state are the product, have not their germs in the lower animals; whether the several parts of our intellectual and moral nature do not insensibly and successively appear in the series of the animal kingdom." He assures us that he approached this inquiry with no preconceived ideas; but we may be permitted to doubt this when we find him bringing in such forced resemblances, as the rolling of pachyderms in mud with the practice of tattooing (vol. i. p. 343), that of ruminants rubbing off their hair to the shaving of men (i. p. 348), and the existence of neuter insects with the custom of castration (i. 351). These and many other similar cases show a determination to find some point of comparison of animals with man, which diminishes the effect of the numerous real and very curious resemblances he has undoubtedly brought forward. In his chapter on the question, whether the power of animals to find their way for great distances depends on a special sense, our author comes to a conclusion which, although we believe it to be a sound one, is opposed to the facts which he adduces. He believes, for instance, that pigeons traverse an unknown country in a direct line, and that dogs and other animals find their way, in cases where neither sight nor smell could guide them. But he shows by many minute observations that animals, *in ordinary cases*, find their way by means of the same faculties which man employs to find his way, and hence he concludes that they do so *in all cases*. But this by no means explains the more extraordinary facts he has first adduced. Here we have an example of his deficiency of information. He quotes the case of the pigeons used during the siege of Paris, and evidently believes that all that was done was to take a carrier-pigeon from any part of France to Paris, when, on being let loose, the bird would infallibly return straight to its former abode. He apparently knows nothing of the fact that these birds must all be trained by means of wider and wider flights over the very country they are to traverse; and that without this precaution, a pigeon, taken by a circuitous route from Brussels or from Bordeaux to Paris, would no more find its way back to those places than would a deaf and dumb man under the same conditions.

In the chapter on the "instinct to use clothing," we have another example of our author's want of rigid impartiality. He endeavours to show that some animals use clothing, and that some men do not, and that it is, therefore, no distinctive character of man. His examples of dressed animals are hermit crabs and the larvæ of *Phryganea* and *Tinea*; and although he adduces instances of unclothed men, he has in no way accounted for that sense of shame which he maintains is not innate, and which yet has, even more than the necessity for warmth, led to the practice of clothing among so many peoples.

In the section on the Sentiments and Passions, we have an elaborate account of the wars, massacres, and cruelties, tortures and human sacrifices, among the various races of men, and we find the characteristic remark, that "the touching custom of preserving a loved one's hair is, perhaps, only a transformation of the old practice of scalping." We commend this notion to Mr. Tylor, as the *ne plus ultra* of survival of savage practices in our modern civilisation. We have also a condensed account of the tortures inflicted on their prisoners by the North American Indians, which can hardly be surpassed for terrible descriptive power; but there is no attempt to find parallels to these essentially human attributes among the lower animals.

Although our author has devoted many pages to a discussion of the principles on which evidence is to be admitted, and has laid down some excellent rules on this subject, he appears to pay little regard to them in his own work. He asserts, for instance, without any reservation, that "a large number of species of apes have a laugh altogether analogous to ours;" but the only evidence he gives of the fact is that "Turks compare Europeans to apes, because they laugh like them;" the grin of anger being here confounded with the laugh of appreciative wit. In like manner he accepts as an undoubted fact the existence of people to whom the use of fire was wholly unknown, although the two cases he gives—the Guanches of Teneriffe, and the Marianne Islanders—are highly suspicious, and have both been shown by Mr. Tylor (in his "Early History of Mankind," a book quoted by M. Houzeau) to be contradicted by many facts, and to rest on no sufficient authority.

It is in Section V., on "Ideas," that we find some of the most curious observations and suggestive remarks to be met with in the whole work. Animals we know, go mad, and they also vary in their mental capacities, but we do not remember any case of idiocy having been recorded among the lower animals. M. Houzeau, however, tells us he had an idiotic dog, which could not take care of itself, and which behaved in an altogether strange and silly manner. But the most curious thing was that its mother observed its mental incapacity, and acted accordingly. From the time when she ceased suckling it, she took great pains to provide its food, bringing it dead birds or pieces of meat, "which she had never done, even for a single day, with any of her other puppies." From this observation, and the well-known fact that animals of the same species differ greatly in their capacity to receive instruction, our author is convinced that it is only through want of observation that we do not meet with mental derangements of various kinds and degrees among our domesticated animals. The faculties of attention, observation, and imitation, exist in a high degree among most of the higher animals; and when we add to these a very retentive memory, and a certain amount of direct and voluntary instruction which parents give to their young, much may be accounted for which has been imputed to those unknown faculties which are termed instinct. Not only does M. Houzeau maintain that the higher animals constantly act by means of intellectual processes altogether comparable to our own, but he extends this view to insects. A German naturalist, Gleditsch, relates that he one day spitted a toad on a stick, which he fixed upright in the ground. A number of burying beetles (*Necrophorus vespillo*) came around it; but as they could do nothing with the toad while in the air, they mined under the base of the stick till it fell, and then buried toad and stick together. The circumstances were quite abnormal for the *Necrophori*, and they acted exactly as an intelligent and reasoning creature would do. Again, when Pierre Huber placed some humble bees (*Bombus terrestris*) under a glass with a piece of comb so irregular that it would not stand firm on its base, they at once set intelligently to work to make it secure, some holding it up while others built walls and buttresses to make all solid. So, again, when the wasp observed by Erasmus Darwin, which could not carry away a large dead fly because the wind caught the wings, cut them off, and was then able to carry away its prey, it acted exactly as an intelligent and reasoning human being would act. As our author well remarks, whenever such facts are brought forward, the usual cry is—"What an admirable instinct!" but instead of having recourse to so miraculous a faculty, able to deal with phenomena occurring perhaps for the first time in the experience of the race, would it not be more simple to suppose these creatures to possess some small portion of our faculties of observation, of memory, and reflection? The following remarks on concluding the whole subject of instinct are well worthy of attention.

"It seems difficult to regard as the effects of a blind instinct such actions as spreading out damp grain in the open air to dry, and taking care of the eggs and the young of captive Aphides. It is difficult to conceive a being performing acts so varied and complex, and so bound one to the other in a connected series of labours, without any perception of the bond of cause and effect which unites them. Animals perform automatically only simple actions depending on their immediate wants. But when the end requires a large number of preliminary and intermediate operations, of a varied character and dependent one upon the other, can we still suppose the entire line of action to be followed out in ignorance and obscurity?" And, after stating the fact of the burying beetles, who, after laying their eggs in the bodies of small dead animals, bury them in order that they may not be devoured by birds and beasts of prey, he continues :—

"If we pretend to see only instinct in this action of the insect, why should we have recourse to a different faculty when man buries his dead? Has not the act of burying for immediate end, in the one case as in the other, the securing the body from the attacks of carnivorous animals? Is there not at the same time, in both cases, a more remote end which forms the true motive of the act? The faculty of invention is doubtless more developed in man than in any species of animal; it is in him more powerful, more elevated, and often directed by nobler motives. But these differences of quantity and of nobility ought not to blind us to the existence of the faculty in various degrees of development among many animals" (ii. p. 236). Bearing also on this question, we have a curious discussion as to the power of animals to appreciate numbers. It is considered to be established that the magpie can count four, which probably refers to Leroy's experiment with crows (NATURE, iii. p. 183). The mule is supposed to be able to count as far as five at least, and this is considered to be established by the following observation. There is a short branch line of omnibuses in New Orleans, where each mule makes the journey five times successively before being changed. The veterinary surgeon of these animals called the author's attention to the fact that, whereas at the end of each of the first four journeys they are silent, as they approach the end of the fifth they neigh. But this does not seem satisfactory. The end of the fifth journey may well be determined by the estimation of mere distance, or of time, or by the sense of fatigue, or, what is still more likely, by some preparations for the change of mules which may be heard or smelt by those arriving. And this is rendered the more probable by an experiment tried by our author himself, showing that dogs cannot count even as far as two. For three successive weeks he repeated the same walk with his dogs on each alternate day; yet, although the dogs were always eager to go out when their master's preparations were seen, on the last trial, being the tenth repetition, none of them showed any knowledge that the day for an excursion had arrived. But neither is this quite satisfactory, as there is too long an interval between each trial, and it rather involves the recollection of a period of time than of a mere number. It can hardly, therefore, be held as proved that the lower animals have any sense of pure number.

Passing on to the consideration of moral and religious ideas, our author adduces the usual proofs that animals have a sense of right and wrong, but which really show nothing more than that they can be made to acquire certain habits through the fear of punishment or the expectation of reward. We next find the broad statement that the idea of duty is not universal among men, but no evidence is offered, except that no one act is held to be a

duty universally, or the contrary. But this is to misapprehend the real question, which is rather, whether there is any race of men among whom nothing is considered a duty. Is there any race with whom there are not certain acts which the majority do, or refrain from doing, independently of any fear of punishment, but because they believe them to be right or wrong? And is there, on the other hand, any race of animals whose actions are influenced in the same way? We think the answer to these questions would show a positive distinction between man and the lower animals, which distinction would hardly be lessened by maintaining that the idea of duty so defined is in savages only the fear of punishment by gods or demons, since it will not be maintained that the lower animals are ever influenced by such motives.

Passing over a curious chapter on the utilisation of the lower animals, chiefly by educating and making slaves of the anthropoid apes, we come to the subject of language, which is discussed in a manner which exhibits the author's defects and merits in a remarkable degree. He thinks it necessary to approach the subject by a discussion on the fables of speaking stones and plants, of the sounds emitted by nudibranch molluscs and fish, the hissing of serpents, and the croaking of toads. By interpreting the notes of certain birds into words, such as "Whip-poor-will," and a number of others, he arrives at the conclusion that some savage languages have fewer letter-sounds than have those of certain animals. The physiology of voice and the construction of speaking automatons is next sketched, before we come to the really valuable part of the chapter, in which the variety of sounds and calls of several species of animals are detailed, and it is thus shown that they possess a language of no contemptible extent. He also maintains that animals understand, or rather learn to understand, the language of very distinct species. His dogs, for instance, perfectly understood his poultry. Cocks and hens have one danger signal for the approach of a bird of prey, another for that of a terrestrial animal or for man. The latter would rouse the sleeping dogs, who would instantly rush out and bark, while they took no notice whatever of the former. This proves that fowls have a language capable of expressing slightly different but closely connected ideas, and also that dogs soon learn the languages of other animals.

The subject of Hereditary Transmission is very imperfectly treated. M. Houzeau is evidently unacquainted with Mr. Galton's researches, or he would not have arrived at the conclusion that "a more or less complete transmission of the physical type with independence more or less absolute of the intellectual and moral type,—such is the law of observation, the law of nature."

In his last lecture on "Sociability" the doctrine is boldly advocated that of all animals Ants approach nearest to man in their social condition. They represent semi-civilised societies; while the highest Apes only represent the lowest savage state. The varied modes of association among the lower animals and in the human race are detailed with great fulness, but with little influence on the general argument. On the question of the affiliation of races, we find some good remarks on the comparative value of the useful arts, the food plants and domesticated animals, as compared with customs and superstitions. The evidence afforded by the latter is, he maintains, absolutely valueless unless supported by the former. In the concluding paragraphs of the work are some expressions and arguments which seem to show that the author is not an evolutionist, and has no clear ideas as to whether new species of animals are now coming into existence or not, or as to whether man has or has not originated from a lower animal form. This leads to an ambiguity and inconclusiveness in the whole work which contrasts strongly with the clear and definite views of such men as Darwin and Spencer, whose works lead us on by many and varied lines of research till they converge towards a grand and impressive conclusion. The present work cannot for a moment be compared with such as these; but it has special merits of its own, and it contains a mass of curious facts, acute observations, and sound reasoning, which fully entitle its author to take high rank among philosophical naturalists.

ALFRED R. WALLACE

GANOT'S NATURAL PHILOSOPHY

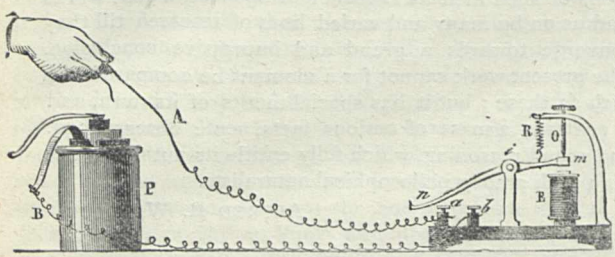
Popular Natural Philosophy. By Ganot. Translated by E. Atkinson, Ph.D. (Longmans and Co.)

THIS is a good elementary book, giving the first principles of the subjects with which it deals in a clear and concise manner, with very few unnecessary words. The work is not an abridgment of Ganot's "Elements of Physics," but is founded on Ganot's "Cours Elémentaire de Physique," of which it is not a mere translation; but additions and alterations have been made by Dr. Atkinson, with the view of rendering it more fit to serve the purpose for which it is designed, namely, to act as a "text-book of physics for the middle and upper classes of boys' and girls' schools, and as a familiar account of physical phenomena and laws for the general reader." The book is very well adapted for these purposes. It is entirely free of mathematical formulæ, which, though but sparsely used in Ganot's "Physics," are still an insuperable barrier to the use of some portions of that work by the non-mathematical reader. The subjects treated of are the same as those in Ganot's "Physics," namely—the properties of matter, hydrostatics, pneumatics, acoustics, heat, light, magnetism, and electricity. The treatment of these subjects is, however, not only more elementary but somewhat less comprehensive than in the larger book. The engravings of the instruments and of the experiments detailed are good and suggestive, and calculated to be of assistance not only to the learner but to the teacher. There is, however, a good deal of what is superfluous in a considerable number of the illustrations, and a few of the illustrations themselves are unnecessary. It is, perhaps, over-refinement of criticism to object to the superfluity of embellishment in Fig. 140, in illustration of a speaking tube. (By the way, how exceedingly small the fire is!) Fig. 139 seems quite unnecessary in explaining the experimental determination of the velocity of sound by the Bureau of Longitude of Paris.

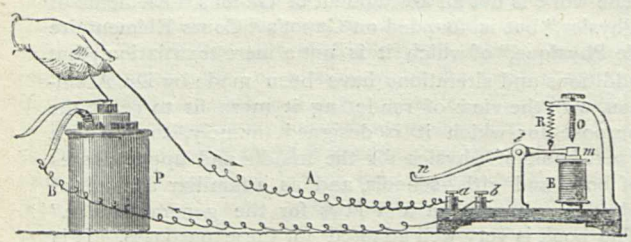
Although, however, there may be a good deal of what is superfluous in the illustrations, there is nothing which is misleading; but, on the contrary, they are in all cases calculated to leave a correct impression of the point in question on the mind of the reader. Fig. 349, however,

of the aurora borealis hardly deserves such a favourable criticism.

As usual with almost all treatises on Natural Philosophy, we have to find fault with the character of the very few remarks which are devoted to terrestrial magnetism; but we know of no elementary book which deals with that very interesting subject sufficiently, and of hardly any which deal with it correctly.



The explanation of the principle of the telegraph is very lucid, and the diagrams connected therewith are exceedingly well adapted for enabling the learner to grasp the principle. The accompanying pair of diagrams in illustration of the principle of Morse's Telegraph leave hardly any verbal explanation necessary.



Diagrams of a self-explanatory character, and which, to a certain extent, stand in place of words, form a very useful feature in an educational text-book.

JAS. STUART

OUR BOOK SHELF

Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt. No. 1, 1872. Band xxii. (Wien.)

THIS part of the Year-book contains three papers devoted to the mining industries of Austria. In one of these—"On the Future of Mining in Austria," by Constantin Freih. v. Beust, we have concise and interesting sketches of the several mineral-bearing regions of Bohemia and Moravia, as also of the various rock formations of the Alpine districts which are metalliferous. The author comes to the conclusion that mining in Austria is capable of vast development, there being goodly stores of silver, lead, zinc, iron pyrites, and even perhaps of gold, which only require energy and enterprise to win them. The same writer contributes a second paper, "On the Direction of the principal Veins in the non-Hungarian Lands of the Austro-Hungarian Monarchy." Franz Ritter v. Hauer also gives some account of the ironstones worked by the Styrian Iron Company near Eisenerz. Dr. Emil Tietze has a long and able memoir on the geology and palæontology of the southern regions of the Banat mountains (Hungary). The descriptions of cretaceous and liassic fossils, many of which are of species new to science, and the illustrative plates that accompany the memoir, are well worthy the attention of palæontologists. In the *Mineralogische Mittheilungen*, edited by Prof. Tschermak, we have, amongst a number of other papers, one by Prof. Inostranzeff of Petersburg, giving the results of his examination of certain limestones and dolomites as bearing on questions of metamorphism. Prof. A. Exner, of Vienna, also contributes a "Chemical Examination of the Meteorites of Gopelpur." Other papers by M. Websky, A. Brezina, and F. Babanek, on mineralogical subjects, will serve to sustain the reputation acquired by our German friends in a department of science which has far too few votaries in this country.

The Metric System of Weights and Measures: an Address delivered before the Convocation of the University of the State of New York, at Albany, August 1, 1871. By Frederick A. P. Barnard, S.T.D., LL.D., President of Columbia College, New York City, &c. (New York, 1872.)

PRINCIPAL BARNARD was appointed, in 1871, by the Trustees of the University of the State of New York to attend a meeting of the Convocation of that University, who were adverse to the introduction of the Metric System, and to enlighten them as to its real nature, and the immense advantages that would flow from its adoption. He seems to have performed his duty with great ability, and we hope with equal success. This volume contains a revised edition of that address, with considerable additions in the form of notes and appendices. Principal Barnard gives a very lucid account of the origin and nature of the metric system, narrating the recent progress of meteorological reform, and answering with what appears to us unassailable arguments the objections commonly urged to its universal introduction into all civilised communities. One appendix contains a long, interesting and useful dissertation on the Unification of Moneys, with some well-arranged information on what has already been prepared and done. In another appendix he describes and discusses the various experiments which have been made to fix on a standard for measures of capacity. His third appendix is on the legislation of Great Britain and of British India in regard to the metric system; and his last appendix contains some very interesting, and what many will deem astonishing, statistics on the extent to which the system has been already adopted. From this we learn that France, Spain, Holland, Belgium (and their colonies), Portugal, Italy, the North German Confederation, Greece, Roumania, British India, and nearly the whole of the countries of Central and South America, have adopted the metric system in full; they represent a population of 336,419,595. Wurtemburg, Bavaria, Baden, Hesse, Switzerland, Denmark, Austria, and Turkey, representing a population of 84,039,209, have adopted metric values; while in Great Britain and the United States, containing a population of 70,373,091, the system is still permissive. In Sweden and Norway (population in 1867 5,897,159) the decimal division has been adopted without the metric values. Thus the peoples already decidedly enlisted on the side of the system include a total population of about 420,000,000. This looks hopeful, and there seems no doubt that this rational system of weights and measures will ere long be universally adopted. One very remarkable fact the author mentions in confirmation of this. At the close of last century, the simple measure of length called the foot had not less than *sixty* different values—probably many more—actually in use in different parts of Europe; in 1867, there could be found only *eight* of this discordant class surviving. We would recommend Dr. Barnard's book to all who wish to possess a clear and intelligible account of the system and its many advantages within a moderate compass.

LETTERS TO THE EDITOR

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

Oceanic Circulation

As some of your readers may be misled by Mr. Croll's reiterated and uncontradicted assertions, that he has *demonstrated* the fallacy of the doctrine of Oceanic Circulation advocated by me, I think it right that they should be made aware that these assertions receive no support from the physicists and engineers, who must be much better judges than either Mr. Croll or I can be, as to the value of the *data* on which his computations are based. His arithmetic may be perfectly correct; but if his fundamental assumptions are wrong, or inapplicable to the case, his demonstration utterly fails.

The report, now in the press, which I have presented to the Royal Society, as to the Deep-sea Researches, on which I was occupied during the autumn of last year, contains my reply to Mr. Croll's argument. And I profited by the unexpected delay in its publication to bring the principal points of that reply before the Mathematical and Physical Section of the British Association at its recent meeting, with the view of eliciting the opinion of the authorities there assembled, as to the soundness of my argument.

I do not think that I claim too much in saying that this opinion was given by Sir William Thomson, and other distinguished physicists, most explicitly in my favour.

Having also had an opportunity of bringing the question under the consideration of Mr. Hawksley, whose experience as a hydraulic engineer is probably second to that of no one living, I found him entirely of my mind; and Sir John Rennie has repeatedly expressed himself as altogether concurring with me.

So far as I know, therefore, Mr. Croll, in his reiterated assertion that water will *not* find its own level—for that, in plain English, is the position he takes—stands "alone in his glory."

The *facts* which I embodied in a paper presented at the same meeting to the Geological Section, in regard to the contrast of temperature between inland seas and the ocean with which they communicate, seem to me inexplicable on any other view than that of a *deep underflow* of Polar water towards the Equatorial area; and this necessarily involves, as its complement, an *upper flow* from the Equator towards the Poles.

When Mr. Croll shall have given some other *rationale* of these facts, he may fairly claim consideration for it. At present I venture to submit that all the *facts* at present known are in my favour; and that Mr. Croll's asserted refutation is purely *theoretical*.

October 4 WILLIAM B. CARPENTER

Consciousness and Volition

IN an interesting review of Lankester's "Comparative Longevity in Man and the Lower Animals," which recently appeared in the *Times*, is the following sentence:—"Once commenced, its continuance (that of the act of walking) is quite involuntary, and may even be unnoticed by the consciousness." I am anxious to ascertain, from those readers of NATURE who have paid special attention to psychology, whether this is, in their opinion, a correct statement of the condition of the mind during such an habitual act as that of walking. There are undoubtedly certain actions of the body, those denominated reflex, which are performed without any exercise of the will whatever; but these are all either momentary, or, if continued, are nearly uniform and unchanging. To me it seems impossible that any action which is constantly varying can be wholly involuntary. Take, for instance, the motion of the fingers in writing: we are absolutely unconscious of the exercise of the mental faculties by which each successive change in the position of the pen is regulated; but yet is it not certain that each up-stroke and down-stroke is the consequence of a separate effort of the will? There is here an evident connection between the state of mind at the time and the action of the body; and by what other means is it possible to suppose that the mental act which conceives the word we are writing can convey its instruction to the fingers? Certainly not by any process of instinct. A better instance perhaps is in the motion of the muscles of the face and throat in speaking. These muscles are entirely under the control of the will; and every separate motion of them must surely be effected by a distinct voluntary effort, of which however we are entirely unconscious. The same seems to me the case in walking. When we sway the body out of the perpendicular in turning a corner, I am at a loss to understand how this can be performed involuntarily. The explanation seems to me to be that consciousness cannot, so to speak, work so fast as volition, and therefore cannot take cognizance of a large number of rapidly successive acts of the will. The question is not so much one of a nice metaphysical distinction as simply of a correct use of terms, although I am afraid I am opposing the views of such high authorities as Huxley and Carpenter. We have been made familiar with the term Unconscious Cerebration. Is there not also an enormous field of Unconscious Volition?

London, Sept. 28 ALFRED W. BENNETT

Phosphorescence in Fish

I HAVE noticed the phosphorescence in fish on two occasions. Once on a calm night, wind light and sea smooth, in the S.E. trades, lat. 18° S., a shoal of porpoises was playing about under the bows of the ship, and darting under her keel for a space of nearly half an hour. Each looked like a piece of burnished silver on blue velvet. They presented the most beautiful appearance. We were not within "soundings." Every wavelet was covered with phosphorescence during the whole of that night, before and after the porpoises were seen. *They* manifestly could not have been the cause of this. As I leaned over the side and watched them, it seemed to me that their phosphorescence resulted from the condition of the water. Off the coast of South America, in about lat. 22° S., long. 30° W., weather much the same, a small shark accompanied the ship for some time, and presented the same appearance. The sea was brilliantly phosphorescent. The fish could be seen deep down. In both cases I saturated paper with the sea water. When dry the microscope failed to detect any organic matter, nothing but crystals.

11, Church Row, Hampstead ARTHUR NICOLS

On a Measuring Apparatus for Direct-Vision Spectroscopes

THERE are few who possess Browning's "miniature," or other small direct-vision spectroscopes, but must have felt the want of some means of measuring the positions of spectral lines; and, indeed, little useful spectrum work is possible without it. I think, therefore, a description of a simple arrangement I have used for some time for this purpose may prove useful.

In the "miniature" spectroscope the outer face of the prism is inclined to the axis of the instrument at an angle of about 40°. Opposite this a hole of about 2 mm. diameter is drilled in the sliding tube, care being taken to avoid injury to the prism. It is obvious that, through this aperture, lateral objects will be visible superimposed on the spectrum. If now a scale be set up opposite to the hole, it will be clearly seen, and the lines may be easily measured by it. The most convenient scale is one of transparent lines on a dark ground (photographed on glass from a scale drawn in black upon white paper), and illuminated by a lamp behind. A paper scale, preferably drawn in white upon black paper, may also be employed. In this case a common retort-stand clamp serves conveniently to hold the spectroscope, while the scale is laid horizontally on the table below. A sheet of paper, may be substituted for the scale, and the instrument used as a camera-lucida. Observation of faint spectra will be much assisted by shading extraneous light with black velvet, and covering the scale on paper with a black sliding screen, with an aperture through which only one or two divisions of the scale can be seen at once. A double scale, of which one gradation corresponds with the upper and the other with the lower edge of the spectrum, is also advantageous.

With a miniature spectroscope, and scale of millimetres at 25 cm. distance, the separation of Na and Li is about 13 divisions, and can easily be read to 0·2 mm.

The arrangement would, I think, be very applicable to the microspectroscope. The small hole is no inconvenience in ordinary use, and can easily be covered by the finger or by a small piece of black paper inserted in the tube.

In conclusion, I would urge the necessity of noting a sufficient number of reference lines at each observation, and the desirability of reducing measurements to the wave-length scale, for which purpose Dr. Watts' "Index of Spectra" will be found invaluable.

North Shields HENRY R. PROCTER

Cat's Toes

AT the village of Cookham-Dean, near Maidenhead, there is a race of cats having more than their normal complement of toes. They generally have six toes on the fore feet, and the usual number on the hind feet; but I saw two individuals which had six toes on each foot, and others which had seven toes on the fore feet, and either five or six on the hind feet. The stock, as far as I can learn from the not over-bright natives, appears to have originated about seven or eight years ago in the person of a "Tom" having six toes on each of its feet. I should think there are now a score or more living in the village.

Harpenden, Sept. 19 R. LYDEKKER

NEW INSTRUMENT FOR THE PRODUCTION OF OZONE

IN the *American Journal of Science and Arts* for July 1872, Prof. A. W. Wright, of Yale College, describes a simple apparatus for the production of ozone with electricity of high tension, and intended for use with the Holtz electrical machine. "The apparatus consists of a straight glass tube about 20 centimetres long and having an internal diameter of 2·5 centimetres, the two ends being stopped with corks covered on the inner side with a thin coating of cement to protect them from the action of the ozone. Through the axis of each cork is inserted a glass tube of about 5 millimetres calibre, and 7 centimetres in length, having a branch tube inserted perpendicularly at the middle, and long enough to permit a rubber tube to be slipped upon it. The outer ends of the tubes themselves are closely stopped with corks, through which are passed straight thick copper wires carrying suitable terminals at their inner ends, and bent into a ring at the others. They are fitted so as to make tight joints, but to allow of motion in order to vary the distance between their inner ends. One of these wires carries a small ball, the other terminates in a disc with rounded edge, set perpendicularly to the axis of the tube, and so large as to leave an annular space of some two or three millimetres breadth around it. The gas is admitted through one of the branch tubes, and escapes from the other after having passed through the whole length of the tube.

"In using the apparatus the wires must be connected with the poles of the machine in such a manner that the disc becomes the negative terminal, as this arrangement gives the greatest degree of expansion and diffusiveness to the current. On turning the machine, and adjusting the ball and disc to a proper distance, a nebulous aigrette surrounds the latter, quite filling the interval between it and the wall of the tube, while the part of the tube between the disc and ball is crowded with innumerable hazy streams converging upon the positive pole, or simply causing the latter to be covered with a faint glow. A current of air or oxygen sent into the tube must pass through this, and ozone is very rapidly produced, and in great quantity. The condensers are of course not used with the machine, when this apparatus is employed.

"The great quantity of the ozone, as well as the ease and rapidity with which it is produced, render the apparatus especially serviceable for use in the lecture-room."

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

IF a good start in life is as serviceable for a society as for an individual, the French Association for the Advancement of Science must be considered as highly fortunate. There has already appeared in NATURE a short account of its first meeting at Bordeaux, and of the papers read there; but the impressions of one of its invited guests may not be altogether without value or interest.

Confessedly the French was framed on the model of the British Association, and doubtless there was wisdom in that; but our friends across the Channel showed their wisdom also in making no servile copy, but endeavouring to modify our plans, so as to suit their national character or special requirements. The reception-room, the card of admission with a map of the town on the back, the various sections in the morning, the discourses in the evening, the municipal hospitality, all reminded us strongly of our own meetings; yet there were some differences that could not fail to strike an English visitor.

In the first place, it was not so popular an assembly. This arose partly from its constitution. There are two kinds of membership; there are the foundation members, who have qualified by taking one or more shares of 500 francs each, and subscribers who pay 20 francs for the meeting or a life composition. By enrolling these members a large society was created with a large capital before ever the first place of meeting was named. And very quickly was this accomplished; for it was only about Midsummer of last year that M. Friedel talked with M. Wurtz as to the best means of extending knowledge through the departments of France, and it was only last Midwinter that the project was nearly shipwrecked by the sudden and lamentable death of M. Combes, in whose rooms the first meeting had been held, and who had been named the provisional president; yet by the aid of large-hearted friends, such as M. D'Eichthal and M. Menier ("Chocolat-Menier"), the promoters of the movement were able to announce in April a sufficient capital to start with, and before the meeting at Bordeaux the Association numbered 700 members, and possessed 140,000fr.

No provision had been made for ladies' tickets, so when the meeting opened there was a sombre uniformity of black coats. But the English visitors brought ladies with them; there was a learned lady, who was believed to be writing for the press, and another, Madame Hureau de Villeneuve, followed her husband's paper on the Steam-engine by reading one of her own on the Flight of Birds. Encouraged by these, several other ladies made their appearance, and brightened the later meetings.

The accommodation afforded by Bordeaux was singularly good. The brilliant concert-room of the great theatre (which is historically interesting from the National Assembly having been convened in it during the German war) was given as the reception-room; and all the meetings were held in the Ecole Professionnelle, a large building just erected in a very substantial manner by the Philomathic Society, with funds bequeathed for the purpose. This new edifice contains a large lecture-room, which served well for the general meetings, and no end of good class-rooms, which accommodated the eleven sections into which the Association was divided. It is intended for the instruction of the working classes of the neighbourhood in the natural sciences, modern languages, drawing, &c., and so the sittings of the large scientific body were a good inauguration of its future work.

The great subdivision of the sections naturally gave rise to but small audiences in each. As far as I could judge, the chemists and the anthropologists were in greatest force; few naturalists or geologists of eminence were present. The sectional proceedings had more the character of a sitting of one of our learned societies than of a morning gathering at the British Association; but besides a couple of hours thus devoted to more abstruse points of science, there was an afternoon sitting at which subjects of more general interest were brought forward. This came intermediate in character, as in time, between the morning sections and the evening discourses; and it is a fair matter for consideration whether it might not be advantageously copied by us.

The papers seemed on the whole superior to those brought forward at our Association, at least there were fewer communications of trivial importance, or old subjects warmed up afresh. Our neighbours, however, find discussion a difficult thing; it is apt to degenerate at once into a conversation between two heated opponents. There was evident also a want of order, punctuality, and respect for authority; previous arrangements were altered, or the decisions of the chair set aside, in the coolest manner. A want of proper organisation arose from the fact that M. Claude Bernard, the president, never made his appearance on account of ill-health; but M. Cornu, the general secretary, was a host in himself; and as M. de Quatrefages has accepted the presidentship of the next meeting at Lyons, and Prof. Wurtz, whose energy and good nature were unfailing at Bordeaux, is to occupy the post of honour the year following, we may hope that the young Association will quickly get over the diseases of infancy.

Festivities were not wanting. Chief among these was a grand reception by the Mayor at the Hôtel de Ville, but I may specially mention a *déjeuner* given by the French chemists to their brethren from England and Belgium, Holland and Spain. Some of us also will never forget the private hospitality we met with.

But the excursions were the great feature of the meeting, and in them the copy certainly surpassed the original. They played a most important part in the proceedings; Saturday and Tuesday were wholly devoted to them; and they took place on Sunday, on Monday afternoon, and through the three days after the close of the sittings.

There was the expedition to Arcachon, where the *savans* not only strolled about the pretty watering-place, but studied natural history at an aquarium which, unlike that at Brighton, was a very unpretending building, but well stocked with interesting marine animals, and paid an especial visit to the oyster-beds that have been formed on sandbanks in the middle of the land-locked sea in front of the town. Here we traced the growth of the favourite mollusc from the spat on tiles, till it was large and plump, and we had explained to us the difficulties of its cultivation, and the ravages committed by a murex called *Carmaillot* (I am spelling at random) and by the hermit crabs. There was an antiquarian expedition to Perigueux and Les Eyzies, where, on each side of the valley, the limestone cliffs are fissured with caverns, in which men lived, and worked in flint and bone, at that remote period when reindeer and mammoths roamed over the soil of France. There was an expedition to see the new "docks" and huge engineering works of the Garonne, which M. Joly carefully explained; and there was a larger excursion by boat and rail down the Gironde to the open sea, where geologists had an opportunity of inspecting the cliffs of chalk and flint, and then the Tertiary strata, beside discussing the subsidence of the Gascon shore, and the shifting of the sandhills, and seeing how they are now prevented from swallowing up villages and churches as they did of old.

But the great excursion was the final one, which extended over three days, and was unique in my experience. Twenty members of the Association were officially deputed to report mainly on the industrial establishments of the Landes and Lower Pyrenees; and any other members were welcome to join the party. Thus was secured a good nucleus of really scientific men, while the expedition had a serious purpose, and it was evidently to the advantage of the establishments visited that we should be well received. The Landes, as is generally known, is a large tract of country which, until lately, was a marsh of sand scarcely capable even of affording pasture; but now it is reclaimed, and the centre of thriving industries. Forests of pine (*Pinus maritima*) have been planted for hundreds of miles, and the trees are regularly scored for turpentine; maize and other crops are grown; and the undergrowth of heather supplies food for myriads of bees. At Labouheyre we inspected the means employed for separating the rosin from the turpentine, and the machinery for impregnating the pine wood with sulphate of copper, so as to fit it for railway sleepers and telegraph posts; and though the thermometer was at 32° C. (say 90° F.) in the shade, and anything you like to imagine in the sun, we also went carefully over some blast furnaces that are used principally for reducing by charcoal the Spanish iron ores which, being free from sulphur and phosphorus, yield an excellent metal.

Here the party was sumptuously entertained by M. Alexandre Leon; and from this stage special trains or special carriages were placed freely at our disposal by the Compagnie du Midi. The next place visited was a primary school at Morcenx, for the gratuitous instruction of the children of their *employés*, which had been carried on by M. Surell the former, and M. Simon the present director of the Railway Company. We found the boys at military drill; we took part in the distribution of prizes, the Association itself giving a reward to the best boy and girl; and as scientific men, we were particularly interested in the good provision for "object lessons," the chemical and galvanic apparatus, and the care with which the children were taught the rudiments of physical and physiological science. Rejoicing at this proof that the reclamation of the Landes was not confined to the soil, we pursued our way to Dax, and spent Friday night at the Thermal Baths, where we enjoyed the hospitality of Drs. Larauza and Delmas, the physicians of the establishment. The springs of nearly boiling water that gush from many parts of the contorted strata under the town were duly examined, and so were the deposits of rock-salt that were accidentally discovered a year or two ago, and which promise to prove an important source of wealth.

From these hot springs we travelled southwards across the Spanish frontier to Irun, and then a good walk through beautiful scenery took us among the granite mountains to the mines of Bidassoa. Here we saw how large faults in the primæval rock are filled with crystallised carbonate of iron, and how the rich ore is won.

Returning into France, where, through the kindness of M. D'Eichtal, a dinner was awaiting us, the expedition found its way back to Bayonne; and, doubtless, on the morrow some of the party visited the pre-historic camp and the ancient abodes of the Troglodytes, according to the programme; but the chemists generally preferred a quiet day at Biarritz.

J. H. GLADSTONE

THE SPIRIT OF SCIENTIFIC CONTROVERSY

AS if in atonement for a prolonged neglect, the study of the organisation of fossil plants is now receiving wide-spread attention. The task first undertaken by Henry Withan has now been shared by many observers. The result is that we already possess a much more complete acquaintance with the ancient vegetation of the globe than we did even a few years ago. But whilst this is undoubtedly true, it is equally so that wide differences of opinion on important points still exist amongst those who have taken a leading part in this investigation. Thus, M. Brongniart and Dr. Dawson believe that the Sigillariæ were Gymnospermous Exogens; whilst Mr. Carruthers and myself are convinced that they were Lepidodendroid Cryptogams. In common with Prof. Schimper and Mr. Carruthers, I regard the whole of the Calamites as Cryptogamic plants, having Equisetaceous affinities; whilst M. Brongniart, M. Grand-Eury, and, perhaps partially, Dr. Dawson, deem some of them to be Equisetaceans, and others Gymnospermous Exogens. Mr. Carruthers and Mr. Binney regard the fruits known

by the name of *Volkmannia Binneyi* to be the cones of Calamites. On the other hand, whilst I do not deny that such may possibly be their nature, I contend that we have neither proof nor even probable evidence sustaining this idea. Dr. Dawson says that Asterophyllites and Annularia are very distinct plants. Mr. Carruthers affirms that they are not. M. Grand-Eury and myself contend that Asterophyllites is wholly distinct, both in type and organisation, from Calamites. Mr. Carruthers believes that Asterophyllites and Annularia are alike the foliage of Calamites. It would be easy to multiply illustrations proving the existence of these opposite conclusions on important points amongst those observers who have enjoyed the best opportunities of forming reasonable opinions on such subjects. It is sufficiently obvious that some of us must be in error on these questions; possibly each of us is so in a greater or less degree; but when we regard the scientific status of the observers to whom I have referred, leaving myself out of the question, I ask, are they men whom we can accuse lightly of carelessness or ignorance? Must we not rather infer that each man has observed special facts leading him to his own conclusions, and that what we want is a careful comparison of such facts with those which have led our fellow-labourers in an opposite direction to ourselves? Whatever may be the explanation of these discrepant opinions, surely our mutual duties are clear. If any of us thinks that his fellow-labourer has made mistakes (and who has not) let him say so openly, and not suggest the idea by indulging in deprecatory insinuations. Let his opposing *argumentum* be *ad rem*, and not *ad hominem*. Further, let it be *ad rem* and not *ad alteram rem*. Let it not rest upon mere analogies, which may or may not be sound. Let us not reject a conclusion before we know all the facts from which it is drawn, merely because we think we have reason to deem it an impossible one. We have all lived to see many such conclusions take their places as undoubted truths.

One source of danger on these points, in the case of fossil botany, arises from the circumstance that though the ancient types of vegetation bear definite relations to the living ones, very remarkable differences present themselves in the combinations of the vegetative and reproductive organs in the two cases. Who, for instance, could have anticipated, from his knowledge of living plants, such an union of the usual vegetative organs of a cycad with an altogether anomalous reproductive system as we see in *Williamsonia gigas*. Many such examples will occur to those familiar with the subject. Hence, whilst a knowledge of living plants is absolutely indispensable to the student of fossil botany,—he cannot have too much of it—we must not allow our knowledge of recent combinations of vegetative and reproductive structures unduly to bias our judgment as to what may occur amongst fossil plants. Whilst we fully recognise the persistence of types, we must equally recognise the wonderful modifications which they have undergone in primæval times.

The conclusions to which these views lead me are very simple ones. The complex problems of palæophytology require harmonious and trustful co-operation amongst observers if truth is to be discovered. Let us supply this in the spirit of cordial fellow-labourers, and not as rivals in pursuit of a fleeting reputation which cannot be shared with others. We shall never raise ourselves by pulling others down. I will not quote the special expressions that are present to my mind whilst penning these lines; but it would be easy to do so, and to show that no possible benefits can accrue to science from their use. We can easily correct our mutual errors, we cannot so easily sooth wounded feelings, or restore shaken confidences. We aim at being the high priests of nature; let us try to banish all disturbing personal and selfish influences from the temple.

These words of warning may appear superfluous, because they embody mere truisms, equally applicable to every branch of human inquiry, or impertinent, seeing that in the fervour of earnest work, I may have erred in the same way as my neighbours. The fact is, that, like others of my earlier fellow-workers, I am rapidly approaching the autumn of life, and peace and harmony now appear more precious to me than they did in bygone years, when youthful ambition was alike active and inconsiderate. Happily ours are not pursuits which require us to cry *væ victis!* Just in proportion as we meet our opponents in a loving and harmonious spirit, without abandoning, in any degree, our earnest contention for what we believe to be truth, shall we, in our declining years, review our past labours with satisfaction and not with sorrow.—*Sic esto.*

W. C. WILLIAMSON

DISTRIBUTION OF HEAT IN THE SPECTRUM

PROF. J. W. DRAPER has communicated to *Silliman's Journal of Science and Art* for September a very important article under the above heading. After detailing a series of experiments on the distribution of the heat of the whole visible spectrum, of the more refrangible and of the less refrangible region, by rock-salt, flint-glass, bisulphide of carbon, and quartz, he thus sums up the results:—

"The important fact clearly brought into view by these experiments is, that if the visible spectrum be divided into two equal portions, the ray having a wave-length of 5768 being considered as the optical centre of such a spectrum, these portions will present heating powers so nearly equal that we may impute the differences to errors of experimentation. Assuming this as true, it necessarily follows that in the spectrum any two series of undulations will have the same heating power, no matter what their wave-lengths may be.

"But this conclusion leads unavoidably to a most important modification of the views now universally held as regards the constitution of the spectrum. When a ray falls on an extinguishing surface heat is produced, but that heat did not pre-exist in the ray. It arose from the stoppage of ether waves, and is a pure instance of the conversion of motion into heat—an illustration of the modern doctrines of the conservation and transmutation of force.

"From this point of view the conception that there exist in an incident ray various principles disappears altogether. We have to consider an incident ray as consisting solely of etherial vibrations, which, when they are checked by an extinguishing substance, lose their *vis viva*. The effect that ensues depends on the quality of the substance. The vibrations imparted to it may be manifested by the production of heat, as in the case of lamp-black, or by chemical changes, as in the case of many of the salts of silver. In the parallel instance of acoustics clear views have long ago been attained, and are firmly held. No one supposes that sound is one of the ingredients of the atmosphere, and it would not be more incorrect to assert that it is something emitted by the sounding body than it is to affirm that light or heat, or actinism, are emitted by the sun.

"The progress of actino-chemistry would be greatly accelerated if there could be steadfastly maintained a clear conception of the distinction between the mechanism of a ray and the effects to which that ray may give rise. The evolution of heat, the sensation of light, the production of chemical changes, are merely effects—manifestations of the motions imparted to ponderable atoms—and these in their turn can give rise to converse results, as when we gradually raise the temperature of a substance the oscillating movements of its molecules are imparted to the ether, and waves of less and less length are successively engendered."

SCOTTISH BOULDERS

THE first Report of the Committee appointed to collect statistics as to boulders, has been recently issued by the Royal Society of Edinburgh, and contains much that is interesting both to the geologist and archæologist. The first object of the committee, and that to which their labours have as yet been solely directed, has been to ascertain the districts in Scotland where any remarkable boulders were situated. Their second object will be to select those which might be deemed worthy of preservation, with the view of requesting landed proprietors and tenants of farms not to destroy them. The committee sent out a printed list of queries, applicable to boulders apparently above 20 tons in weight, one of the queries being directed to ascertain the occurrence of "kaims" or "eskars," *i.e.* long banks of sand or gravel. The following are some of the most important results educed by the inquiry :—

"1. From a tabular list we learn that Aberdeenshire possesses the largest number of boulders, and also the boulders of greatest magnitude. Ross and Cromarty stand next, then Perth, Argyll, Inverness, Kirkcudbright, and Forfar.

"2. In regard to size, the largest boulder reported is one of granite, in the Parish of Pitlochry, called 'Clach Mhor' (big stone), being about eight yards square, and estimated about 800 tons. There are two boulders between 500 and 600 tons weight, one in Ross, the other in The Lewis. There are three boulders, between 200 and 500 tons, seven between 100 and 200 tons, twenty between 50 and 100.

"3. With regard to the nature of the rocks composing the boulders, the largest reported are of granite, though there is one known to the convener of the committee, still larger, of conglomerate, in Doune parish. The most numerous are composed of compact greenstone; but these are generally of small size. The next most numerous class are of grey granite. There are also many of gneiss, graywacke, and conglomerate.

"4. The boulders reported generally differ in regard to the nature of the rocks composing them from that of the rocks of the district in which they are situated; and, in many of the reports, reference is made to the district from which the boulder is supposed to have come. Thus, in those parts of Perthshire, Forfarshire, and Kincardineshire where the Old Red sandstone formation prevails, and over which multitudes of granite, gneiss, and conglomerate boulders are lying, most of the reporters have no hesitation in pointing out that the parent rock is in the Grampian range, lying to the north or west. So also in Wigtonshire, where the graywacke formation prevails, and on which many boulders of grey granite are lying, the general opinion is that they came from the granite hills of Kirkcudbrightshire.

"5. The boulders mentioned in the reports are of various shapes. Some approach a cube, well rounded of course on the corners and sides. That is the shape mostly possessed by granite boulders. Others again are of an oblong shape, and this is particularly the case with whinstone and graywacke boulders. A point of some importance occurs in regard to oblong-shaped boulders. The direction of their longer axis, in the great majority of cases, is stated to coincide with the direction in which they have come from the parent rock, when the situation of that rock has been ascertained. Thus in Auchterarder parish, there is a boulder 10 ft. long by 6 broad, the longer axis of which points north-west. In Auchtergaven parish there is a granite boulder 10 ft. long by 8 ft. broad, the longer axis of which points due north. In Memuir parish, Forfarshire, there are two large granite boulders, the one 14 ft. by 9 ft., and the other 13 ft. by 9 ft., the longer axis of which points north-west. In each of these cases the reporters seem satisfied of the situation of the parent rock, and in each case the longer axis of the boulder points towards it. It appears, also, that where there are natural striations or ruts on the boulders, these almost always run in a direction parallel with the longer axis; and that when there are striæ crossing these the number of such oblique striæ is comparatively few.

"6. Notice in the reports is taken of the remarkable positions occupied by some boulders. Thus, the Ardentinny report refers to a large boulder called 'Clachan Udalain,' or the nicely balanced stone, so called, as the reporter states, because 'it stands on the very edge of a precipice, and must have been gently deposited there.' On Iona, near the top of the highest hill in the island, which is about 250 feet above the sea, there is a great boulder of granite. There is no granite in the island. The nearest place where that rock occurs is in the Ross of Mull, &c., with an arm of the sea intervening.

"7. With regard to kaims or long embankments of gravel or sand, there are twenty-three parishes reported to the Committee as containing them. They appear to be most numerous in Aberdeenshire, Forfarshire, and in the east of Perthshire. In Kemnay parish there is a kaim said to be 2½ miles long, running east and west. In Airlie parish there is a kaim 2 miles long, also running east and west. In Fettercairn parish, Kincardineshire, and also in Tarbet parish, Ross-shire, there are several kaims parallel to, and not far distant from, one another."

The committee proceed next to notice points of archæological interest connected with boulders, and are surprised at the large number of them possessing names by which they are known in the districts to which they belong. The names may be classified under several heads :—First, there are names having reference to the agency by which the boulders were supposed to have come into the district. Second, there are names indicative of the use to which boulders were put. Third, there are names making the boulders commemorative of certain events. Fourth, some boulders form such prominent landmarks that they have been used to mark the boundaries of estates, parishes and counties, and are still in many parts of Scotland recognised as affording evidence on that subject. On these points the committee give some very curious information which must be highly interesting to archæologists, and indeed to all who take an interest in the history of the race.

Great numbers of boulders have legends attached to them, one of the commonest being that the boulder was thrown to the spot where it lies by some giant, demon, or even by "Auld Nickie Ben" himself, for some wicked purpose of course; and it is very interesting to notice, that almost invariably, the place from which the legend says the huge stone was thrown, is the nearest spot containing the formation to which the boulder belongs. It is well known that, as a rule, boulders differ from the formation on or in which they are found, and in reference to what we have just mentioned, the place from which the giant or devil took his throw is often at a very considerable distance, sometimes on a different island. For example there is a large conglomerate boulder near the top of a hill, in the island of Edag, one of the Orkneys, which goes under the name of the "Giant's Stone." The legend says it was flung by a giant from the island of Stronsay; now there is no conglomerate rock which could have supplied the boulder in Edag, though there is in Stronsay.

The British Association at its last meeting so highly approved of the scheme of the Royal Society of Edinburgh, that it appointed a committee of some of its most influential geologists to carry out a similar scheme for England and Ireland.

The committee are very anxious that the boulders reported on should be examined by experienced geologists, who may be visiting the districts where they are situated, and are willing to lend the reports they have received on condition that the results of the inspection be made known to the committee.

ON THE FERTILISATION OF A FEW COMMON PAPILIONACEOUS FLOWERS

[NOTE TO EDITOR.—THE enclosed paper was written in the autumn of 1869, and then submitted to Mr. Darwin. With his usual kindness he encouraged me to proceed with it; and with his usual thoroughness he advised me to make it more complete than it is before giving it to the public. At the same time, he lent me various publications containing articles on the subject of fertilisation, and, amongst others, some by the Italian botanist, Delpino, who has done so much in this field. I found that he had in two or three publications in the years 1867 and 1868, anticipated most of the observations contained in the accompanying paper; and I proposed to myself to attempt a *résumé* of what had been done of late years in the matter of fertilisation of flowers by Delpino, Hildebrand, and others. But this, though a labour of love, is a greater labour than I can manage, and other calls have grown upon me. I therefore send the paper to you as it stands, begging that this note may be prefixed in order that I may not be thought to be appropriating Delpino's observations.—T. H. F., *October* 1872.]

AFTER reading Mr. Darwin's book on Orchids and his papers on Lythrum and Primula, I made some notes on the fertilisation of Phaseolus and some of the Campanulaceæ, which had the good fortune to meet with his approval, and which he had the kindness to send for publication to the Annals and Magazine of Natural History, where they appeared in October 1868. The comparison of Phaseolus with other Papilionaceous flowers led me to think that Mr. Darwin's fertile ideas might receive many illustrations from the structure and functions of this beautiful and interesting tribe; and the following are observations made during the summer of 1869 upon

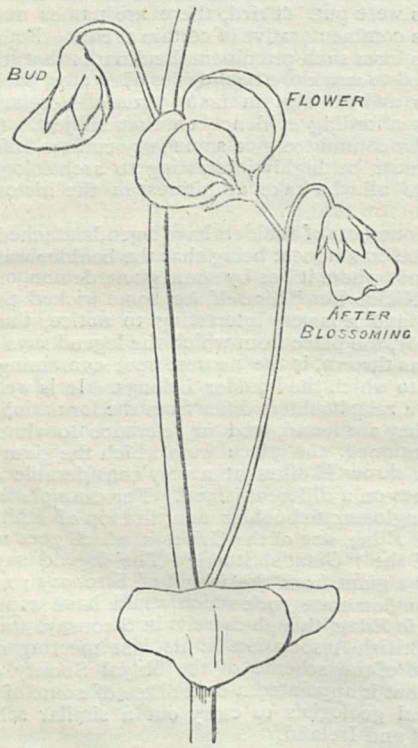


FIG. 1.—*Pisum sativum* (Common Pea) (peduncle and pedicels).

a few of the commonest of them. I am painfully conscious how imperfect want of time, of opportunity, and of knowledge has left them; and how many points there are, even in these few flowers, which require a much more careful inquiry. Indeed, every new flower has its own peculiarity; and almost every new peculiarity suggests the observation of facts in other flowers not previously noticed; so that the task is endless. Again it is difficult to feel sure of a conclusion unless the whole process of fertilisation by insects can be watched, and to a dweller in towns, ignorant of insects and their habits, it is impossible. If, however, these observations should lead to further inquiry and discussion, they may not be useless. The flowers in question are *Pisum sativum*, several species of *Lathyrus*, *Vicia*, and *Phaseolus*, *Robinia pseud-Acacia*, *Wistaria*, *Onobrychis sativa*, *Trifolium repens* and *T. pratense*, *Lotus corniculatus*, *Lupinus*, *Ononis*, *Anthyllis*, *Ulex*, *Genista*, *Sarothamnus*, and *Cytisus*.

Pisum sativum, or Common Pea.—The blossoms are generally two upon a common peduncle, and each flower has a separate short pedicel (see Fig. 1). The peduncle generally approaches the perpendicular and

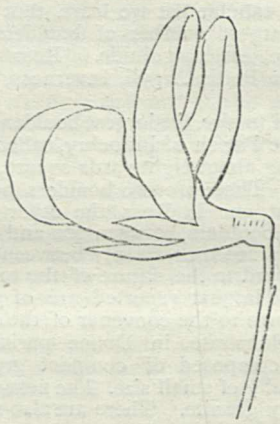


FIG. 2.—*Pisum sativum* (mature flower).

maintains its position through the stages of bud, blossom, and pod, except that it gets stiffer. The short pedicels, however, change their position twice. In the bud they are bent down so that the base of the calyx is uppermost, and the upper edge of the folded vexillum lowest. In this stage the large calyx covers with a weather-proof awning the tender blossom. As the flower opens the pedicel straightens itself; and when the blossom is fully open it is quite straight, and at an angle of 45° to the peduncle. The effect of this is to raise the flower so that the keel and wings become almost horizontal, whilst the showy limb of the vexillum, bent upwards from the claw, displays a perpendicular face (see Fig. 2).

The wings are slightly attached to the keel at the base of their limbs; and the limbs project outwards and a

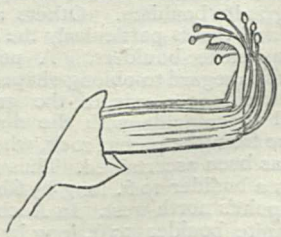


FIG. 3.—*Pisum sativum* (lateral view of pistil and staminal tube, with calyx and corolla removed, and tenth stamen separated).

little upwards in front of and above the keel, so as to make an excellent lighting place for insects. The keel is boat-shaped, recurved at the apex, and the lower edges

are joined together from the base to the apex. The stamens are diadelphous, the filament of the tenth stamen being separate at the summit and base, and separable in the middle (see Fig. 3). They are of nearly equal length, the pollen is abundant and rather moist, and is shed at the time the blossom expands. The upper parts of the filaments are stiff enough to keep their place, but not so stiff as the style. The lower parts of the filaments form a stiff tube, expanded towards the base, so as to leave a large cavity round the base of the ovary. This cavity is abundantly supplied with nectar. On each side of the tenth stamen at its base, there is a wide aperture, through which apertures, on removing the vexillum, this cavity with its nectar is easily seen (see Fig. 4).

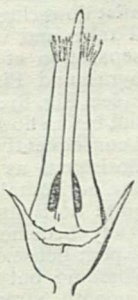


FIG. 4.—*Pisum sativum* (front view of staminal tube, with tenth stamen, front showing apertures into nectary on each side the tube).

The style is at right angles to the horizontal ovary, and curves towards the vexillum at the top. The stigma is at the extremity, and faces outwards and upwards towards the vexillum. On the inside for some distance below the stigma it is clothed with stiff hairs, which are set so as to point upwards towards the stigma (see Fig. 5). The style appears to be formed by two folds of the carpellary leaf, which bend outwards from the point where the style joins the ovary, so that the outer side or back of the style which lies towards the suture of the keel, and which has no hairs on it, is formed, not of the outer suture of the carpel, but of the edges of these folds.

At the time the flower opens the stamens have shed, or are shedding, their pollen, which lies in an abundant mass at the apex of the keel around and above the stigma.

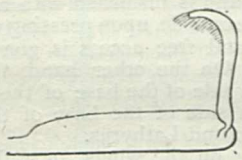


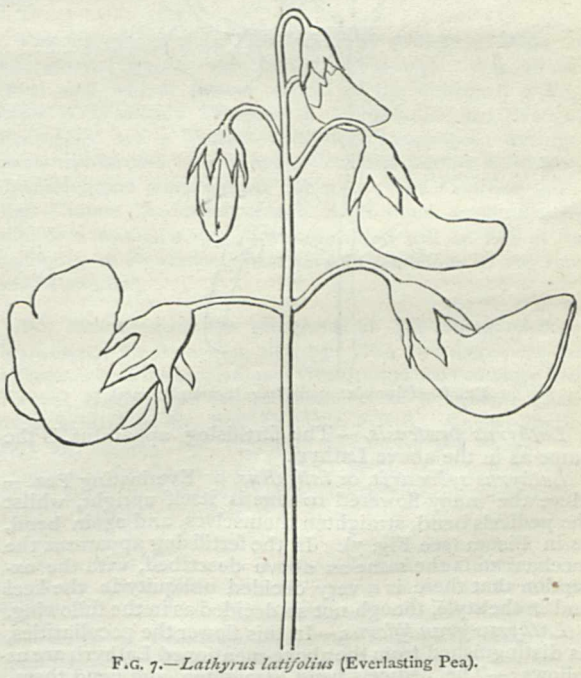
FIG. 5.—*Pisum sativum* (pistil).

The back of the stiff elastic style almost touches the keel; and on pressing down the wings, which, as above noticed, are attached to the keel, the back of the style, which has no hairs, is pressed against the keel, whilst the brush on the front and sides of the style sweeps the moist pollen upwards and pushes it out of the apex of the keel and against any object which is entering the flower, and to which the pollen, being moist, will adhere. On removing the pressure the parts take their place again, whilst on repeating the pressure the same process may be repeated, until the whole of the pollen in the upper part of the keel is brushed out.

As soon as the flower closes and before it withers, the pedicel again droops, the flower becomes pendent, and the calyx again acts as a pent-house to the young pod (see Fig. 1).

Now, undoubtedly, the stigma of one of these flowers is always covered with its own pollen; but if self-fertilisation were the rule, the elaborate structure I have described is meaningless, whilst if the purpose is that insects shall carry the pollen from flower to flower, it becomes a curiously elaborate and complete piece of mechanism having a special object. The change of position of the flower by the bending, straightening, and second bending of the pedicel, so that the tender opening bud and the young fertilised ovary are protected from rain and cold; whilst the open blossom displays itself in the most attractive and convenient form and position for insects; the conspicuous vexillum; the wings, forming an alighting place; the attachment of the wings to the keel, by which any body pressing on the former must press down the latter; the staminal tube inclosing nectar, and affording by means of its partially free stamen with apertures on each side of its base, an open passage to an insect seeking the nectar; the moist and sticky pollen placed just where it will be swept out of the apex of the keel against the entering insect; the stiff elastic style so placed that on a pressure being applied to the keel, it will be pushed upwards out of the keel; the hairs on the style placed on that side of the style only on which there is space for the pollen, and in such a direction as to sweep it out; and the stigma so placed as to meet an entering insect,—all these become correlated parts of one elaborate mechanism; if we suppose that the fertilisation of these flowers is effected by the carriage of pollen from one to the other.

FIG. 6.—*Lathyrus* (keel and pistil).



F.G. 7.—*Lathyrus latifolius* (Everlasting Pea).

I have, however, not observed the bees or other insects at work on these flowers, whilst they are to be found in abundance on the neighbouring broad beans and scarlet

runners. Do the white pea-blossoms attract night-flying insects?

Lathyrus odoratus.—This is, so far as the above functions are concerned, so like Pisum, that it is scarcely worth while to dwell on the differences. In colour and smell, of course the difference is great, and consequently in the attractions for different insects. The changing position of the pedicels; the brush to the style; the free or partially free stamen, and the nectar inside the case of the staminal tube, and the openings into that tube, are the same (see Fig. 6).

Lathyrus macrorhizus, is, so far as I have observed it, similar.

Lathyrus pisiformis is like the other Lathyri in the above points, except that in the long raceme of flowers, the whole peduncle, and not only the pedicels of the separate flowers, is pendent in the bud. It stiffens and becomes upright as the blossoms open, and the pedicels also stiffen and become horizontal. After flowering the peduncle remains stiff and upright, but the pedicels droop.

FIG. 8.—*Phaseolus multiflorus* (Scarlet Runner).

Lathyrus pratensis.—The fertilising apparatus is the same as in the above Lathyri.

Lathyrus sylvestris, or *latifolius*, or Everlasting Pea.—Here the many-flowered raceme is itself upright, whilst the pedicels bend, straighten themselves, and again bend, as in Pisum (see Fig. 7). In the fertilising apparatus the mechanism is the same as above described, with the exception that there is a very decided obliquity in the keel and in the style, though not so decided as in the following.

Lathyrus grandiflorus.—In this flower the peculiarities, as distinguished from the above-mentioned Lathyri, are as follows:—The pedicels bend, straighten, and bend themselves again, as above mentioned; but the effect generally, if not universally, is to make the large showy vexillum, and not the keel, horizontal. The vexillum, consequently, and not the keel, would be the natural alighting place for an insect. The wings are at right angles to the vexillum, and the recurved point of the keel projects between them and overhangs the vexillum. An insect alighting on the vexillum, and thrusting itself towards the nectary, must push the wings, and with them the keel, upwards, and make the style and the pollen come out; but they will come out downwards on to the back of the insect, and not on to his thorax or belly.

Another peculiarity is that the keel, and with it the style, is very oblique, and the upper part is flattened, and is twisted so that the back of the style does not press against the keel. Correlatively both sides of the style are well furnished with hairs, and both sides equally operate in sweeping the pollen out of the keel. In this respect *Lathyrus grandiflorus* seems to show a gradation towards Phaseolus.

Phaseolus multiflorus, or Scarlet Runner.—In the position of the blossom whilst flowering, in the nectar-holding cavity of the staminal tube, and in having an entrance to the cavity by the separation of the tenth stamen, this flower resembles Lathyrus and Pisum, but it offers the following peculiarities (see Fig. 8):—

The pedicel of the bud before flowering is perpendicular and stiff, and the bud consequently upright; the pedicel becomes rather more horizontal as the flower opens, and in blossom the wings are horizontal, whilst after flowering the pedicel becomes quite horizontal, and the pod gradually sinks, and ultimately becomes pendent. Correlatively, there is no large pent-house of a calyx, as in Pisum, to protect the young blossom; but the same object seems to be effected by the smooth, strong, thick vexillum, the edges of which are in the bud closed valvately over the tender folded interior petals; whilst in the bud of Pisum the whole of the petals, whilst sheltered by the calyx, are tender and unclosed. The young pod of Phaseolus, also unlike the thin glabrous pod of Pisum, is thick and covered with short hairs.

The keel, which in some Lathyri is very oblique, is in Phaseolus so twisted, and has its edges so joined, as to form an imperfect tube containing the stamens and style; it makes with them nearly two complete spiral turns, and its mouth points obliquely downwards. The stiff, elastic style is clothed with stiff hairs or bristles, forming a circular brush at the point in the tube where it is surrounded by, and in contact with, the moist, sticky pollen of the mature anthers. The stigma is on the lower side of the style, just appearing at the mouth of the tube, is sticky, and is clothed with fine hairs.

The filament of the tenth stamen is entirely separate from the others, and is furnished with a sort of tooth or appendage on the outside, upon pressing which the stamen is drawn back, and free access is given to the nectar-holding cavity. On the other hand, there is no such aperture on each side of the base of the tenth stamen as there is on each side of the base of the semi-adherent filament in Pisum and Lathyrus.

A bee lighting on the wings, or rather on the outer wing, opens for himself a way to the base of the flower. At the same time, the wing being attached to the spiral tube of the keel, he pulls it outwards, the consequence of which is that the stiff style is thrust outwards and at first downwards, so that the sticky stigma first touches the entering insect and sweeps from his proboscis any pollen he may have brought from other flowers. As he passes further, the stigma protrudes further, turns upwards, and the brush of the style, loaded with the sticky pollen of its own anthers, sweeps against, and leaves its load on, his proboscis, with which he departs for other flowers.

The mechanism of this flower is truly wonderful. For further details I could refer to papers by Mr. Darwin in the *Gardener's Chronicle* of October 24, 1857, and November 14, 1858, and to the notes of my own in the *Annals and Magazine of Natural History*, October 1868.

Phaseolus vulgaris is similar to *P. multiflorus*.

T. H. FARRER

(*To be continued.*)

NOTES

DR. T. STERRY HUNT, F.R.S., for more than twenty-five years an officer of the Geological Survey of Canada, has resigned his position there, and goes to Boston to the Massachusetts Institute of Technology, where he is to fill the chair of Geology, left vacant by the resignation of Prof. William B. Rogers. He was to enter upon his new duties on October 7.

THE examination which has been held in common by Magdalen and Merton Colleges, Oxford, for scholarships in Natural Science, terminated on Saturday, when the following elections were made :—To demyships at Magdalen College, value 95*l.*, for five years : Mr. W. J. P. Wood, Clifton College ; Mr. C. H. Wade, The Owens College, Manchester. To a postmastership at Merton College, value 80*l.*, for five years : Mr. W. H. Jones, Derby.

THE centenary of Linnæus's death will be celebrated at Stockholm on the 10th of January, 1873, when a statue of the great Swedish naturalist will be unveiled.

THE Meteorological Congress will meet next year at Vienna, and the meeting will be a very important one, for which the one recently held in Leipzig was only a preparation ; the condition of the Continental observatories and of the large British ones will then form a grave subject for discussion.

WE learn from *Les Mondes* that the construction of meteorological observatories on the summit of the Puy-de-Dôme is now about to commence. Two observatories, connected by a telegraphic wire, the one in a pavilion of the faculty at Clermont, the other on the summit of the mountain, 1,160 metres above the lower one, will show every moment the difference of meteorological condition between the plain and the upper regions of the atmosphere. The money allotted to this purpose is 100,000 francs, one half being furnished by the town and department, the other half by the State.

THE Commissioners of Her Majesty's Works and Public Buildings intend to distribute this autumn, among the working classes and the poor inhabitants of London, the surplus bedding-out plants in Battersea, Hyde, the Regent's, and Victoria Parks, and in the Royal Gardens, Kew. If the clergy, school committees, and others interested, will make application to the Superintendents of the Parks nearest to their respective parishes, or to the Director of the Royal Gardens Kew, in the cases of persons residing in that neighbourhood, they will receive early intimation of the number of plants that can be allotted to each applicant, and of the time and manner of their distribution.

THE Annual Fungus Exhibition was held in the Council Room of the Royal Horticultural Society, on Wednesday the 2nd inst. There were several extremely good collections, both of the edible and poisonous kinds, many of the rarer edible species being well represented, while some of the commoner ones were almost entirely absent. Prizes for the best collections were given by Mr. W. W. Saunders, F.R.S.

AN exhibition of useful insects and their products, and also of noxious insects, with samples of the injuries caused by them, organised by the Central Society of Agriculture, and under the patronage of the Minister of Agriculture and Commerce, will be held during this month in the Luxembourg Gardens in Paris. It will comprise silkworms and their cocoons of every species, with samples of thrown and raw silk ; apparatus for silk culture ; with the manufacture and raw product of bees, and apparatus for bee culture ; a collection of noxious insects, and apparatus suited for their destruction ; other useful insects ; collections of mammals, insectivorous birds, and reptiles, &c. The programme of the exhibition may be obtained of the Secretary of the Society of Agriculture, 59, Rue Monge, Paris.

THE *Journal of Botany* records the death, after a short illness, of a well-known Continental botanist, Andreas J. Oersted, Professor of Botany in the University of Copenhagen. He had travelled and collected largely in Central America, and had written much, especially on cryptogamic botany.

DR. EICHLER, of Gratz, editor of Martius's "*Flora Brasiliensis*" has accepted the appointment of Professor of Botany at Kiel, Holstein. No change will be involved in the publication of the great Flora.

AQUARIA seem to be quite the rage at the present time. A new large aquarium is to be built at Great Yarmouth on the north beach. A space of seven acres has been granted by the Corporation a short distance to the left of the Britannia Pier, and here, in addition to the aquarium, gardens will be laid out, and a museum and gymnasium built.

THE fine new Guildhall Library is almost completed, and will be open free to the public very shortly. In addition to the Library proper, the basement will be used for carefully storing the old charters and records belonging to the Corporation, and a handsome room, 80 ft. long by nearly 50 ft. wide, will be devoted to the Museum, and it is hoped will become a receptacle for all the objects of antiquarian interest found in the City of London. Above the Museum is the Library proper, a noble room, 120 ft. long by 50 ft. broad, and nearly 60 ft. in height. The open oak roof will be highly ornamented and enriched, and the windows will be filled with stained glass, the two chief windows being presented by the London and Middlesex Archæological Society, and by the inhabitants of the Ward of Aldersgate.

THE first session of the New University College of Wales at Aberystwyth was to open to-day (Thursday). The educational staff will at present consist of the Principal, a Professor of Classics, a Professor of Mathematics and Natural Philosophy, and a Teacher of Modern Languages. Arrangements will be made as soon as practicable for lectures in Geology, Chemistry, and other cognate subjects. The Principal is the Rev. Thomas Charles Edwards, M.A., to whom application for admission must be made. An examination will be held at the beginning of the session, when several exhibitions of 20*l.* each will be awarded.

WE have received the prospectus of The Owens College, Manchester, for the session 1872-73. The most important new arrangement is the separation of Geology and Palæontology from Natural History, and the establishment of a separate Chair, which is filled by Mr. Boyd Dawkins, F.R.S. Animal Physiology and Zoology, and Vegetable Physiology and Botany, remain under the charge of Prof. W. C. Williamson, F.R.S. The Manchester Royal School of Medicine is incorporated with The Owens College.

THE courses of lectures in connection with the Franklin Institute for the winter session 1872-73, to be held in the Hall of the Franklin Institute, Philadelphia, will comprise Experimental Chemistry, Mineralogy, Metallurgy, Hygiene, Physics, Technical Chemistry, Fire, and Photography.

IT is proposed to incorporate the courses of evening lectures on scientific subjects delivered at the Polytechnic Institute into an institution to be called the Polytechnic College. They are largely attended by young men, many of them engaged during the day in shops.

THE following scientific lectures will be delivered in connection with the Newcastle-upon-Tyne Literary and Philosophical Society during the session 1872-73. "The Progress of Solar Research," by J. N. Lockyer, F.R.S., Oct. 21 and 23. "New Illustrations of Divine Contrivance in Nature," by Prof. S. Haughton, M.D., Oct. 28 and 30. "Water; its Nature, Circulation, and Functions," by Prof. D. Page, LLD, Nov. 4 and 6. "The Life, Character, and Work of Faraday," by Dr. J. H. Gladstone, F.R.S., Nov. 18 and 20. "On Stellar Astronomy," by Prof. R. Grant, Dec. 6 and 13. "Oil Coals, Oil Shales, and Oil Wells," by A. Taylor, Dec. 16, 18, and 20. "On Polarized Light," by W. Spottiswoode, F.R.S., January 29, and 31, 1873. "Early Moral and Political Condition of Mankind," by E. B. Tylor, F.R.S., Feb. 5 and 7.

LECTURES will be delivered during the ensuing session in connection with the Oldham Literary and Philosophical Society, on the following subjects:—"Star Depths," illustrated by Oxyhydrogen Lantern and Photographic Sides, by R. A. Proctor. "Flame," illustrated by experiments, by Prof. J. H. Core. "Balloon Ascents for Scientific Purposes," by James Glaisher, F.R.S. "The Origin of the British Flora." by L. C. Miall, "The Caverns of Devonshire," by W. Pengelly, F.R.S. "Sand, Gravel, and Clay; or, an Arctic Climate in Britain," by J. E. Taylor. "Folk-Lore of Natural History," by Robt. Holland. This will be the second session, the first having been decidedly successful.

THE distribution of the prizes and certificates in the Guildford Science Classes took place on September 20, under the presidency of Lord Midleton. The classes have been very successful during the past year, the members under instruction in the various subjects amounting to seventy-seven, against forty-four in the previous year; and the proportion of certificates awarded being larger than the average of all England. Guildford is showing in the institution of these classes an example that might well be followed by other towns whose opportunities are greater. We are sorry, however, to learn that up to the present time the committee has entirely borne the brunt of the elementary expenses, not one sixpence having been contributed by the public of Guildford during their three years' existence. This is not as it should be. Probably in time our country towns will learn that their own interest is involved in cultivating a knowledge of science.

THE *Astronomical Register* for October contains the first instalment of an article on astronomical allusions in Homer, Dante, Shakespeare, and Milton, Homer and Dante being treated of in the present number with great care and fulness of knowledge. The subject is an interesting one, and we believe Mr. G. J. Walker's treatment of it will be of service towards a history of the progress of man's knowledge of the heavens.

FROM the same periodical we learn that the new dome for the Edinburgh Observatory, alluded to in a recent number of NATURE, is now erected, and admirably fulfils all the expectations formed of it, such as increased space inside, greater ease of revolution, larger and more easily worked shutter, better ventilation, and freedom from vibration and bumping. This latter curious quality was a very vicious propensity of the old dome, partly from its being mounted on cannon balls, which enabled it to roll in every other direction as well as in that of the line of railway, wherein it was wanted to roll; and partly from the unprecedentedly windy and stormy exposure of the Edinburgh Observatory on the summit of Calton Hill. The new dome, therefore, may be considered a very creditable piece of engineering, and a decided success on the part of Mr. Howard Grubb.

WE learn from the *British Medical Journal*, that 300 young Russian women have claimed admission as students in medicine and surgery at the newly opened Medical School of St. Petersburg. The number of admissions being fixed, however, at 70, there will be a great many disappointed.

THE Volcano of Santorin, when last visited in October 1871, had ceased giving the small eruptions which had been common almost without intermission since the great eruption of 1866, and the summit of the crater, covered with great blocks of lava, presented the same appearance as in 1707. A little steam was still escaping, but this seemed due almost entirely to the vapour of water condensing on the cinders covering the cone. In the north the fumerolles were still active, and all around the stones were covered with sulphur. At the S.E. point the volcanic activity had not completely ceased, but had greatly diminished. All this would show that the eruption had entered on its last stage, and after a period of great central activity in 1866-67, accompanied by a diminution of activity in 1869-70, it is now again assuming a condition of rest and quietude.

THE completion of the Australian Land Telegraph is a great scientific feat, for by it London is now within a few hours' communication with Adelaide and all the other centres of population on the Australian continent. Whilst the Suez Canal, the Mont Cenis Tunnel, and the Pacific Railway, are undoubtedly great and stupendous works, the carrying of a line of telegraph across the uninhabited and almost unknown interior of Australia for 1,800 miles is a great result, especially when performed single-handed by the colony of South Australia. Some interesting discoveries have been made during its progress. The river Roper has now been ascertained to be a noble river, and the only one in Australia navigable for large sea-going steamers and ships for 100 miles from the sea, and some apparently very productive gold fields have also been found.

AURORÆ BOREALES have been very conspicuous lately. On the 25th of August one was seen at Thurso and at Hernösand in the Gulf of Bothnia and feebly also at Lisbon.—On the 26th at Sévres and also at Stockholm.—On Sept. 2, at Sévres, Stockholm, Reval and Windaw.—On Sept. 3, at Sévres, Paris, Hernösand, and Rome.—On the 4th, at Sévres, Paris, London, and Archangel.—On the 5th, at Sévres and Paris.—On the 6th at Hernösand. So that there have been in Europe, during the period from the 2nd to the 6th of Sept., an almost continuous succession of Auroræ visible in England, France, Scandinavia, Russia, and once in Italy.

A WHITE Aurora Borealis was observed at Baumette near Angers, on the 8th of August, by M. A. Cheux, who thus describes it.—About 10 o'clock the sky was lit up in the N.N.W., by a white light; and at successive intervals white rays were shot out mostly towards the North or North-West. At about 10·30, a magnificent white ray shaped like a fan, and 22° in height, occupied the northern part of the sky. This gradually faded, and by 11·30 the sky had resumed its natural colour. This is the fourth Aurora Borealis observed in the last four months, the others having been seen on the 9th of May, the 9th of June, the 10th of July, and this on the 8th of August. The coincidence in these monthly dates is something remarkable.

PROF. O. C. MARSH, of New Haven, has been diligently at work during the past summer in elaborating the rich mass of fossil vertebrates collected by him last year and the year before in various parts of the West. His latest discoveries are two large pachyderms allied to *Palæosyops*, a gigantic fossil tapir called *Hyrachyus princeps*, two carnivora allied to the *Viverridæ*, and, most important of all, two species of bats (*Nyctitherium velox* and *N. priscus*), the first of the order ever detected fossil in America.

SIEBOLD'S NEW RESEARCHES IN PARTHENOGENESIS *

AMIDST the all-absorbing discussion of the problems which have arisen out of the general acceptance among biologists of the law of evolution, the phenomenon of Parthenogenesis which, previously to Mr. Darwin's work on the Origin of Species, excited the interest and called forth the investigations of observers in much the same manner as his theory has done of late years, has met with a reverse of fortune and fallen into a subordinate rank of popularity. The distinguished naturalist, however, who fifteen years ago gave so stunning a blow to current theories of the reproductive process, by demonstrating the occurrence in moths and bees of what he designated as "true parthenogenesis" —that is to say, the development, without impregnation, of an ovum capable of being impregnated—has not let the subject drop. Professor Siebold has made further experimental researches, establishing again, and on a larger basis, his former conclusion, and adding at least one new fact of great general importance for the understanding of the process of sexual reproduction. Although upon its first appearance in 1856, the conclusion arrived at in his "Wahre Parthenogenesis" was admitted by almost all competent naturalists to be thoroughly demonstrated, and beyond the reach of criticism; yet some more and some less eminent biologists have not been wanting to deny the *Lucina sine concubitu*, and have raised such objections as that of a possible error in the condition of the experiments depending on the exclusion of males from the supposed parthenogenetic female; and again, that these so-called females were not demonstrated "not to be hermaphrodites." Indeed so deeply rooted is the conviction that eggs are made to be impregnated by spermatozoa, and that they then, and then only, can proceed to develop, that Siebold felt it necessary to add to his proofs, in order to establish his position that not only do unimpregnated eggs develop into perfect animals, but that such an event is by no means an exceptional occurrence among certain groups, and has a definitely fixed and orderly recurrence amongst them. He naturally was also anxious to extend the class-limits within which a true parthenogenesis can be said to occur, and he desired to inquire into the sex of the parthenogenetically-produced offspring in such cases as could be critically and decisively studied. Hence the renewed researches which have extended over several years, and the results of which are given in the present brochure.

Von Siebold's merit in this and his former work (but more especially in this) is not the enunciation of a new theory, or hypothesis, but the great care, ingenuity, and persistence which he has displayed in investigating cases in which for many years collectors, bee-keepers, and such naturalists of the limited, or "gardener" type, had asserted reproduction by means of unfertilised eggs to take place. It must be remembered that he was himself a strong opponent in 1850 of the supposition which he has now shown to be justified in fact, and that Leuckart in his article "Zeugniss," in Wagner's Handwörterbuch, and in other publications, preceded him as an advocate for the existence of true parthenogenesis, endeavouring, by microscopical researches, to give a solid observational basis to Dzierzon's hypothesis. It was not until 1857 that Siebold published his observations on bees, demonstrating what had been previously supposed, viz., that the queen-bee exhausts her store of received sperm in fertilising eggs which give rise to females only, and that then she lays unfertilised eggs, which become drones only, whilst the unfertilised worker-females also lay eggs which give rise to drones, and again that in certain moths (*Psyche* and *Solenobia*) unfertilised ova develop and produce females only. Leuckart followed (1858) with his "Zur Kenntniss des Generations-wechsels und der Parthenogenesis bei den Insekten." In this work, whilst asserting his claims to the merit of first espousing the cause of true parthenogenesis, Leuckart gives an excellent view of the general signification of the phenomena, and insists on the importance of extended histological observation in the examination of alleged cases of parthenogenesis. In his present work Siebold cannot be charged with in any way neglecting this part of his subject, for he has given most important and minute descriptions of the generative organs of the two principal cases studied (*Pōlistes* and *Apus*), containing new facts. His method is however eminently experimental, and appears to us a striking contradiction of a very superficial classification of the sciences, which is favoured sometimes by men of science unacquainted with the methods or problems of biology: we mean the division into the exact or mathematical, the experimental, and the classificatory sciences, in which last division the so-called natural history sciences are said to find their place.

The experiments which Siebold made on bees and wasps, though performed by a naturalist, are as nicely controlled, and as clear in the conclusions which they give, as any performed by exact physicists on the times or quantities concerned in this or that physical process. The style in which details of these investigations are communicated is one rare at the present day in biological works, where minute description of structure, or of the apparatus devised for a physiological research, form the staple. Here we are treated to a leisurely narrative of some years of patient work; we share the keen enjoyment of the author as he becomes acquainted with the marvellous intelligence of his wasps and their various proceedings—we feel his satisfaction in overcoming the difficulties of procuring and observing the necessary material, and admire the candour and thoroughness with which he handles the question before him.

Before proceeding to a short notice of the contents of Von Siebold's book, it will be well to give a brief statement of the signification which such inquiries as his have in the present state of knowledge. Harvey's dictum, "Omne vivum ex ovo," expressed a great law, which had to be qualified when the researches of Trembley and others made known, among Polyps, and Worms, and Protozoa, reproduction by fission. To this rapidly succeeded the recognition of a modified fission, in which the animal did not divide into equal parts, nor exhibit the power of reproduction of the whole animal in artificially detached portions of its body; but in which special sprouts or buds were found to be prepared and detached spontaneously, becoming then developed into perfect animals. This process received the name of gemmation, and was stated to occur in polyps and also in the plant-lice. Parallels for these methods of reproduction in animals were readily recognised in plants, in the multiplication by seed, by cuttings or shoots, and by separable buds. A broad line was drawn between "buds" and "eggs," however egg-like the former might appear, in the assumption that eggs were special bodies of a peculiar structure, destined to be "fertilised" by the spermatozoa of the male—after which process only could they develop. These distinctions, some twenty years ago, were the more firmly impressed in the minds of biologists by the then recently acquired knowledge of the process of fertilisation or impregnation. Then came the demonstration by Siebold of the capacity for development of true eggs, even when not impregnated. The sharpness of the limit between buds and eggs was by this at once destroyed; and the closely following researches of Leydig (antecedent to Siebold's work in some cases), Huxley, Lubbock, and Leuckart, on the structure of the supposed buds of Aphis and allied insects, and of lower crustaceans, proved that these bodies were morphologically ova—originating in ovaries, and having the essential structure of fertilisable ova. For them the term "pseudova" was introduced by Prof. Huxley, since they differ in this respect from other ova—that whereas the latter can be, and are in most cases (though with constant exceptions), fertilised, the latter cannot be.* Whilst, then, up to this period such a thing as parthenogenesis appeared to be a strange exception, the question has now shifted, and, since the essential identity in reproductive power of cuttings, buds, pseudova, and eggs is proved, the problem before naturalists is rather, "Why are eggs ever fertilised?" in short, "What is the use of the male sex at all?" We have animals and plants multiplying by fission, breaking up into two or more parts, each of which becomes a new individual; we have them giving rise by growth to masses of cells, which become detached or remain attached, and develop each into a new individual; and finally, we have them elaborating single large cells, which become detached and develop each into a new individual. Why should it be that in certain cases these last require the fusion of another peculiar kind of cell elements before they will develop? Some light seemed to be thrown on this matter at first, by the observation that the unfertilised ova of the bee always produce drones, and that only the fertilised produce females; but this indication of a possibly clearer insight into the matter is entirely upset by the fact, now fully established in the present work, that in some species of

* "Beiträge zur Parthenogenesis der Arthropoden." Von C. Th. E. von Siebold, Professor der Zoologie und Vergleichenden Anatomie in München. Leipzig: Engelmann, 1871.)

* Leuckart has more recently proposed, in describing the reproduction of the Cecidomyia larvæ discovered by Wagner, to limit the term "pseudovum" to such ova as those produced by larvæ, or imperfect forms; and not to apply it at all to the eggs of bees, wasps, &c. (which can develop without fertilisation), as was done by Huxley. The falsity implied in the prefix seems to make a rather stronger distinction than is desirable between any of these bodies; for they are all truly ova, though ova of various special properties.

insects and crustaceans the unfertilised ova always, or in an enormously large proportion, produce females only; whilst in the Aphides we know that they ultimately produce both males and females. Mr. Darwin has suggested the most satisfactory theory of fertilisation, in assigning to it the object of fusing two life-experiences in the progeny, which thus gains tendencies and acquires impulses from a wider area than does an unfertilised ovum, and is in so far strengthened. Conjugation of two cells, similarly formed but belonging to different individuals (as seen in Confervæ and Gregarinæ) is the simplest arrangement for obtaining this end; the only difference between this and sexual reproduction is that in the latter process one cell seeks, the other is sought; and this differentiation into active and passive, the wooer and the wooed, commencing in the simplest vegetable and animal cells, persists to the highest rank of development. Self-impregnation (if it have a real physiological existence) and parthenogenesis, have, then, to yield, as chief modes of reproduction, to digenesis, or the concurrence of two individuals; and this for one and the same reason. Perhaps the apparently anomalous facts that an animal—or plant, as the case may be—develops elaborate motile zoosperms and copulatory organs, merely to fertilise its own egg; and that other animals and plants develop peculiarly constructed large cells, of a kind apparently especially elaborated in the progress of the general evolution of life, to provide for fertilisation, yet which never are fertilised—are only to be explained as cases of persistent structures with modified function. In the former case, Monogenesis, being sufficient to or necessitated by the conditions of life, yet avails itself of the apparatus inherited from digenetic ancestors; whilst similarly, in the second case (pseudova), Monogenesis, having advantages for the particular case (and not being a common phenomenon in the group), instead of making its appearance through new organs, avails itself of the ovary inherited from digenetic progenitors. Thus the unsignificant form of an ovum (unsignificant, that is, so far as monogeny is concerned) takes the place of the more obviously appropriate bud or fisssion-product. The phenomenon of Alternation of Generations, usually treated of in connection with parthenogenesis, should by experiment on the physical conditions accompanying its variations enable us to ascertain a great deal more than is at present known of what is the signification of the differentiation of male and female sexual elements; and it is from further study of this and of True Parthenogenesis that progress in this part of physiology may be expected.

To return to Siebold's researches. The greater part of the book is devoted to an account of the parthenogenesis observable in the wasp Polistes. Leuckart first recorded in his work already mentioned, that the workers of wasps, ants, hornets, and humble bees lay eggs, which in one case he followed to the development of a larva, but of which he was not able to determine the sex. Siebold determined to study a species of Polistes common in and around Munich, which he identifies with much care, and after reference to specimens and authorities from many lands, as *Polistes gallica* var. *diadema* Latreille. He gives a minute description of the characters of the females and males; the two kinds of the former (queens and workers) being only distinguishable by size—the workers in all external characters as well as in their generative organs being merely smaller queens, and fully capable of copulation and impregnation. In the beginning of May, in Munich, the Polistes queens which were born in the previous summer and impregnated then, commence each to build a nest. No queen who built in the former year survives to build a second time, and the young queens never make use of the old nests. The Polistes are very particular in choosing a warm sunshiny spot, sheltered from wind and rain, and as such spots are not too common, a new nest is often begun near the weathered remains of an old one. Walls and trunks of trees, often at such a height as not to be easily reached, are the sites chosen. When the queen has constructed fifteen or twenty cells, she lays eggs in them, and is very hard-worked in guarding her nest and in providing food for the larvæ as they hatch. She feeds them on caterpillars and other soft insects, first removing the alimentary canal (as cooks take out the entrails of a fish), and carefully applying the morsel to the lips of each larva. This process takes some time for one "hand," and hence the first brood is longer in coming to perfection than later broods, in the rearing of which the elder progeny assist. In the middle of June the first lot make their appearance, all small females ready to assist their parent in the advancement of her enterprise. The later broods develop more rapidly and acquire larger size from being better nourished, and towards the end of June (no drones being as yet born) the females which come forth are as large as the old queen; they may, however, be easily distinguished from her by their comparative freshness of colour and wing. Great care is displayed in guarding the nest. At night the queen goes to sleep after having carefully inspected each cell, taking up her position at the hinder side of the nest. If she is disturbed in the night, she takes another survey of her house before again going to sleep. In the daytime if disturbed she makes an immediate attack on the enemy with her sting, and then flies back to her nest. She can sting several times, since the barbs on her weapon are not too long to allow of its being withdrawn. Ants are amongst the most common of the many insect enemies of these wasps, and when one ventures into the nest, the whole colony sting it to death, and immediately throw the body out. Birds are, however, not thus to be got rid of, and destroy immense numbers of the nests, so that Siebold was obliged to protect those he wished to study with nets. The members of one nest are not allowed to remain in another, if by chance a stranger comes in she is hustled out at once by the wasps near the entrance. Siebold convinced himself of this by painting the thorax of a number of Polistes belonging to different nests with different colours. Only late in the year, when the wasps seem to be getting careless or tired of their incessant work did he find that one or two had got mixed in certain colonies, to which they did not rightly belong. Although there is this sharp discrimination of individuals, yet it was found that by substituting one nest for another whilst the queen was away, she could often be deceived, so as to make her enter upon the possession of the substituted nest as though it were her own. Siebold found this a very useful plan when he wanted to change the position or locality of a nest so as to bring it into a safer or more accessible spot, or when a nest which he had been observing was by some accident deserted, or when a nest in a favourable position was less forward in the development of its larvæ than one less favourably situated. By making the nests moveable, and substituting the one for the other in the absence of the queen, he was able to save himself much trouble and loss. The nests were made moveable by removing them from their original support and firmly fixing them to boards which were then hung up in the original position. The queens were very anxious after this operation had been performed, investigating with great care the strength of the support and the cord by which the board was hung, and sometimes adding to it themselves additional strength. By degrees such moveable nests could be lowered a little bit each day from an inconveniently high position, or taking the nest in the night under a cover whilst all the wasps were in it, it could be removed from a distant locality to the Professor's garden; in such cases a certain proportion always came to grief by the desertion of the colony; and the queen was then sometimes found at work on the old site constructing a new nest. Although strangers are not admitted in a well-regulated Polistes nest, yet by carelessness or desertion the brood of one colony will sometimes be exposed to the attacks of the workers of another, who then make use of the unfortunate larvæ to feed their own young. It frequently happens that workers who have once indulged in this kind of thing, become what are called "robber wasps," utterly demoralised, and actually undo the whole labour of a colony by dragging out the grubs which they were lately so carefully tending in common with their fellows, to feed the still younger larvæ. When this condition of things has once begun in a colony it soon goes to ruin, and hence it is necessary to destroy any deserted Polistes nests in the neighbourhood of those under observation, lest by entering the former the members of the latter should get the bad habit of pulling grubs out of their cells, and proceed to do the same in their own nests.

The rain is a very constant source of destruction to Polistes colonies, drowning the young by saturating the cells with moisture. Light rain will not, however, do much harm. Whilst Siebold was endeavouring to remove some of the water from a nest which had been drenched in a shower, he was astonished to find the wasps themselves already busy at the work, putting their heads into the cells, sucking up the water, then passing to the edge of the nest and spitting out the fluid. In this way they are able to get rid of the effects of a wetting if it is not very severe. Though the Polistes feed their young exclusively with animal food, they yet appear to collect a sweet fluid which Siebold found in some cells, and which he thinks the workers take for their own enjoyment, since they were seen entering such cells and apparently sucking at the contents—in fact, taking a little refreshment in the intervals of their labour.

The development of the grub is carefully described by the author, and a "pseudo-nymph" stage is recognised intervening between the nymph and the pupa. The perfect insect bites off the lid of its cell, and comes out with perfect wings, deposits first of all a drop of urinary excretion, and makes a trial flight, then returns to take part in the labours of the colony. The cell is often used again for another egg. The first drones make their appearance with the beginning of July, an important fact for Siebold's experiments, for if the nest is to be used at all now is the latest moment; they have to be killed off, and all the remaining larvæ and pupæ destroyed—in order to secure a colony consisting solely of virgins. The drones play a pitiable part in the nest—sneaking about in the empty cells and behind the comb, not till the month of August are their generative organs fully developed, and then they make their first approaches to the females. Their proceedings are minutely described, and it appears that they meet with many rebuffs from the busily-occupied workers of the hive, and that it is outside at a distance from the nest that their addresses are at length accepted by those of the larger females destined to become queens. Not all the large females appear to have this destiny, and none appear to leave the nest until all the brood has been brought through, when (about the beginning of October) the nests become deserted. Only a few flattened old virgin wasps remain, who are killed off by the frosts, whilst the young queens have married and sought out for themselves winter quarters. Siebold distinguished black-eyed and green-eyed drones, and speculates upon the signification of this difference.

Having ascertained these and other matters relating to the Polistes in far greater detail than we have been able here to indicate them, Siebold was prepared to make his experiment. In the nest from which he wanted an answer to these questions, "can unfertilised Polistes females lay eggs which will develop?" and if so, "of what sex will the parthenogenetically produced progeny be?" he proceeded to destroy the queen and all the eggs, larvæ, and pupæ in the cells with the greatest care as late as possible in the season, so as to have as large a colony as possible left, the limit of the time being given by the date of the appearance of the first drone. The queens thus taken were used for careful histological study of the generative organs, and since in all cases Siebold found the *receptaculum seminis* filled with moving spermatozoa, he was able to feel assured that he had really removed the queen in each case. We will merely direct the attention of those interested in histology to the minute description here given of the ovary, which in the main agrees with Leydig's, and of the *receptaculum seminis*, which in opposition to Leydig, on account of its nerve supply, Siebold holds to be contractile. After waiting some days Siebold had the gratification of finding the first eggs laid in the cells of several of the nests from which he had removed queen, eggs, and larvæ, and he felt convinced that they could only have been laid by the small virgin workers who alone tenanted the combs. The whole affairs of the colonies proceeded just as well as when the queens were there, and the virgins watched and worked with the same assiduity as had done their queen-mother. In some cases Siebold actually saw a worker deposit an egg, and such egg-laying workers, when anatomically tested, showed, firstly, in the presence of *corpora lutea* (the precise signification of which the investigator had ascertained by his histological studies of the ovary) that eggs had been extruded, and, secondly, in the complete absence of spermatozoa from the *receptaculum seminis*, that the insect was a virgin. Out of a hundred nests which he had begun to observe in one season, and out of one hundred and fifty in another, only some twenty or so in each case came through all the long series of accidents from weather, insects, birds, &c., to which they were necessarily exposed, and some of those which promised the best results and had cost the most pains came to a bad end in the very last days of the research. In order to determine the sex of the wasps born from the eggs laid by the parthenogenetic females, Siebold in most cases only allowed the development to proceed sufficiently far to enable him to recognise the sex by anatomical investigation. The dried skin, however, of such grubs as were found dead in their cells afforded sufficient evidence of the sex. In all cases the parthenogenetic offspring was without exception male. The queen-wasps as we have mentioned also late in the season lay eggs which produce drones, which are easily distinguished from the drones parthenogenetically produced by their larger size. It occurred to Siebold when he first ascertained that the queens produce drones that such drones might visit his virgin colonies, and thus his whole experiment be invalidated. He was, however, reassured on this point by a nearer acquaintance with the Polistes; for such drones are not born till later than the period at which his small females laid their eggs, the former event taking place at the end of July, the latter at the beginning; and, furthermore, as we have noticed above, it is not till still later (August), when the experimental cells were long since all occupied with eggs, that the power and desire of sexual activity comes to these drones.

E. R. LANKESTER

(*To be continued.*)

ON INSTINCT*

WITH regard to instinct we have yet to ascertain the facts. Do the animals exhibit untaught skill and innate knowledge? May not the supposed examples of instinct be after all but the results of rapid learning and imitation? The controversy on this subject has been chiefly concerning the perceptions of distance and direction by the eye and the ear. Against the instinctive character of these perceptions it is argued that, as distance means movement, locomotion, the very essence of the idea is such as cannot be taken in by the eye or ear; that what the varying sensations of sight and hearing correspond to, must be got at by moving over the ground by experience. The results, however, of experiments on chickens were wholly in favour of the instinctive nature of these perceptions. Chickens kept in a state of blindness by various devices, from one to three days, when placed in the light under a set of carefully prepared conditions, gave conclusive evidence against the theory that the perceptions of distance and direction by the eye are the result of associations formed in the experience of each individual life. Often, at the end of two minutes, they followed with their eyes the movements of crawling insects, turning their heads with all the precision of an old fowl. In from two to fifteen minutes they pecked at some object, showing not merely an instinctive perception of distance, but an original ability to measure distance with something like infallible accuracy. If beyond the reach of their necks, they walked or ran up to the object of their pursuit, and may be said to have invariably struck it, never missing by more than a hair's-breadth; this, too, when the specks at which they struck were no bigger than the smallest visible dot of an *i*. To seize between the points of the mandible at the very instant of striking seemed a more difficult operation. Though at times they seized and swallowed an insect at the first attempt, more frequently they struck five or six times, lifting once or twice before they succeeded in swallowing their first food. To take, by way of illustration, the observations on a single case a little in detail:—A chicken at the end of six minutes, after having its eyes unveiled, followed with its head the movements of a fly twelve inches distant; at ten minutes, the fly coming within reach of its neck, was seized and swallowed at the first stroke; at the end of twenty minutes it had not attempted to walk a step. It was then placed on rough ground within sight and call of a hen, with chickens of its own age. After standing chirping for about a minute, it went straight towards the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after life. It never required to knock its head against a stone to discover that there was "no road that way." It leaped over the smaller obstacles that lay in its path, and ran round the larger, reaching the mother in as nearly a straight line as the nature of the ground would permit. Thus it would seem that, prior to experience, the eye—at least the eye of the chicken—perceives the primary qualities of the external world, all arguments of the purely analytical school of psychology to the contrary, notwithstanding.

Not less decisive were experiments on hearing. Chickens hatched and kept in the dark for a day or two, on being placed in the light nine or ten feet from a box in which a brooding hen was concealed, after standing chirping for a minute or two, uniformly set off straight to the box in answer to the call of the hen which they had never seen and never before heard. This they did struggling through grass and over rough ground, when not able to stand steadily on their legs. Again, chickens that from the first had been denied the use of their eyes by having hoods drawn over their heads while yet in the shell, were while thus blind made the subject of experiment. These, when left to themselves, seldom made a forward step, their movements were round and round and back-

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ward ; but when placed within five or six feet of the hen mother, they, in answer to her call, became much more lively, began to make little forward journeys, and soon followed her by sound alone, though of course blindly. Another experiment consisted in rendering chickens deaf for a time by sealing their ears with several folds of gum paper before they had escaped from the shell. These, on having their ears opened when two or three days old, and being placed within call of the mother concealed in a box or on the other side of a door, after turning round a few times ran straight to the spot whence came the first sound they had ever heard. Clearly, of these chickens it cannot be said that sounds were to them at first but meaningless sensations.

One or two observations favourable to the opinion that animals have an instinctive knowledge of their enemies may be taken for what they are worth. When twelve days old one of my little *protégés* running about beside me, gave the peculiar chirp whereby they announce the approach of danger. On looking up, a sparrow-hawk was seen hovering at a great height over head. Again, a young hawk was made to fly over a hen with her first brood of chickens, then about a week old. In the twinkling of an eye most of the chickens were hid among grass and bushes. And scarcely had the hawk touched the ground, about twelve yards from where the hen had been sitting, when she fell upon it, and would soon have killed it outright. A young turkey gave even more striking evidence. When ten days old it heard the voice of the hawk for the first time, and just beside it. Like an arrow from the bow it darted off in the opposite direction, and crouched in a corner, remained for ten minutes motionless and dumb with fear. Out of a vast number of experiments with chickens and bees, though the results were not uniform, yet in the great majority of instances the chickens gave evidence of instinctive fear of these sting-bearing insects.

But to return to examples of instinctive skill and knowledge, concerning which I think no doubt can remain, a very useful instinct may be observed in the early attention that chickens pay to their toilet. As soon as they can hold up their heads, when only from four to five hours old, they attempt dressing at their wings, that, too, when they have been denied the use of their eyes. Another incontestable case of instinct may be seen in the art of scraping in search of food. Without any opportunities of imitation, chickens begin to scrape when from two to six days old. Most frequently the circumstances are suggestive ; at other times, however, the first attempt, which generally consists of a sort of nervous dance, was made on a smooth table. The unacquired dexterity shown in the capture of insects is very remarkable. A duckling one day old, on being placed in the open air for the first time, almost immediately snapped at, and caught, a fly on the wing. Still more interesting is the instructive art of catching flies peculiar to the turkey. When not a day and a half old I observed a young turkey, which I had adopted while yet in the shell, pointing its beak slowly and deliberately at flies and other small insects without actually pecking at them. In doing this its head could be seen to shake like a hand that is attempted to be held steady by a visible effort. This I recorded when I did not understand its meaning. For it was not until afterwards that I observed a turkey, when it sees a fly settled on any object, steals on the unwary insect with slow and measured step, and, when sufficiently near, advances its head very slowly and steadily until within reach of its prey, which is then seized by a sudden dart. In still further confirmation of the opinion that such wonderful examples of dexterity and cunning are instinctive and not acquired, may be adduced the significant fact that the individuals of each species have little capacity to learn anything not found in the habits of their progenitors. A chicken was made, from the first and for several months, the sole companion of a young turkey. Yet it never showed the slightest tendency to adopt the admirable art of catching flies that it saw practised before its eyes every hour of the day.

The only theory in explanation of the phenomena of instinct that has an air of science about it, is the doctrine of Inherited Association. Instinct in the present generation of animals is the product of the accumulated experiences of past generations. Great difficulty, however, is felt by many in conceiving how anything so impalpable as fear at the sight of a bee should be transmitted from parent to offspring. It should be remembered, however, that the permanence of such associations in the history of an individual life depends on the corresponding impress given to the nervous organisation. We cannot, strictly speaking, experience any individual act of consciousness twice over ; but as, by pulling the bell-cord to-day we can, in the language of ordinary discourse, produce the same sound we heard yesterday, so, while the established connections among the nerves and nerve-centres hold, we are enabled to live our experiences over again. Now, why should not those modifications of brain-matter, that, enduring from hour to hour and from day to day, render acquisition possible, be, like a ny other physical peculiarity, transmitted from parent to offsp ring? That they are so transmitted is all but proved by the facts of instinct, while these, in their turn, receive their only rational explanation in this theory of Inherited Association.

ON THE TREE-FERNS OF THE COAL MEASURES, AND THEIR AFFINITIES WITH EXISTING FORMS *

LINDLEY and Hutton describe two species of tree-ferns from the Coal Measures, both from the Bath Coal-field. I have been able to add eight species hitherto undescribed, chiefly through the assistance of Mr. J. M'Murtrie, of Radstock. These belong to three groups, which are remarkably distinguished by peculiarities in the structure of the stems. Two of the groups belong to living forms, while the third is extinct, being confined to Palæozoic formations. *Caulopteris* and *Tubicaulis* belong to the same type as the living ferns which possess stems, including under this term the humble stems (falsely called rhizomes) of many of our British species, as well as the arborescent ferns of warmer regions ; and excluding the rhizomatous forms like *Pteris*, *Polypodium*, and *Hymenophyllum*. In all these stems we have a central medulla, surrounded by a continuous vascular cylinder penetrated regularly by meshes, from the margins of which the vascular bundle or bundles to the fronds are given off, and through which the parenchyma of the medulla is continuous with that of the stipes. In most tree-ferns the medullary axis is larger, and the bases of the stipes decay down to the circumference of the stem, but in *Osmunda* the persistent bases of the stipes permanently clothe the small vascular cylinder which encloses a slender pith. To this latter form belongs the stipe with a dumbell-shaped vascular bundle, separate specimens of which I have obtained from the Coal Measures. These have been described both on the Continent and in this country, under the name of *Zygopteris*, but they belong to Cotta's genus *Tubicaulis ;* and they are very closely allied to a group of fern stems which I have already placed together under the name of *Chelepteris*. The stem structure of the common tree-fern is represented by the genus *Caulopteris*, of which I have six species of carboniferous age.

The third and extinct group is represented by Corda's genus *Stemmatopteris*, only now known to be British, and by *Psaronius*, which is, however, not a separate generic form, but only the internal structure of the stems of which Corda's genus is the external aspect. The chief characters of *Psaronius* have been drawn from the structure of the aërial roots which invest the stem, from which, indeed, the generic designation was derived ; while the structure of the stem itself has been overlooked. But this is really of the first importance, as will appear from the following description which I have been able to make from a finely preserved specimen of an undescribed species in the British Museum, and from the figures of Cotta and Corda. The circumference of the stem was composed of a continuous envelope of indurated tissue ; within this there were perpendicular tracts of vascular tissue never penetrated by any mesh. Between these tracts the leaves were given off in perpendicular series, the large single leaf bundles coming right out from the central parenchyma, where they existed as well-formed bundles, filling up more or less completely the medullary cavity. In one form (*Zippea*) the leaves are opposite, and the great proportion of the circumference of the stem is made up of the persistent and common vascular tissue ; in others (species of *Psaronius*) the permanent elements of the stem consists of three, four, six or more perpendicular tracts.

The first two groups are analogous in the arrangement of the parts of their stems to that which exists in the first year's growth of a dicotyledon. In both there is a parenchymatous medulla surrounded by a continuous vascular cylinder, which is perforated in regular manner by meshes for the passage out of the vascular elements of the appendages. The stems of the third group have a structure analogous to that which is found in the stems of monocotyledons, for in both we have the vascular

* Paper read before the British Association at Brighton in Section C, Aug. 19, by W. Carruthers, F.R.S.

bundles of the appendages existing in the parenchymatous axis, and passing out independently of any closed cylinder. The permanent elements of the circumference of these stems of *Psaronius* are, however, without any analogue in the monocotyledonous stems.

There seems, then, good reason for establishing two groups of ferns, with differences characteristic of their stems, comparable to those which distinguish the stems of monoctyledons from those of dicotyledons. But the caution I have always insisted on in dealing only with vegetative organs is specially required here, for I have discovered, I believe, the fruiting fronds of one species of this group of plants. With the Bath specimens of *Stemmatopteris insignis*, Corda, as well as with those found on the Continent, the fronds of *Pecopteris arborescens* are always associated. It is the only fern found with some of the Bath specimens. It is also to be observed that the bases of the stipes correspond with the size of the leaf scars on the stems. These facts are not absolutely sufficient for the correlation of the fronds with the stem, but they are the best evidence for this that we can expect in fossil botany short of actual organic union. Now the fruit of *Pecopteris arborescens* is so near to that of *Cyathea* that I can find no characters whereby they can be separated. Our classification based on the stems must of course yield to that derived from the organs of fructification, and our group of ferns, instead of being made into a new order, as would be the case by some who publish on fossil botany, must be grouped with a tribe of recent *Polypodiaceæ*.

It may seem that this is a forced and arbitrary grouping together of plants that in some important characters so remarkably differ; and so it is undoubtedly to those who, with rash confidence, generalise on the systematic position of plants from stem structure alone. But what can such objectors say to the practice of placing in close proximity plants that are beyond question nearly related to each other in all essential characters, though some have caudices, while others possess rhizomes; yet these two forms of stems are yet more widely separated from each other than the extinct palæozoic group is from the recent forms.

SCIENTIFIC SERIALS

THE double number (Nos. 5 and 6) of the *Annalen der Chemie und Pharmacie* commences with a paper by Carl Grunzweig, on "Butyric acid from different sources." He prepared the perfectly pure normal and isobutyric acids and their salts, and examined their properties very carefully; he then examined butyric acid as obtained from butter, which he finds to be normal butyric acid, and the acid from the oxidation of conine and that from the carob, or St. John's bread, are also the normal acid.—Von Schneider contributes a long paper upon pollen and wax formation; which is followed by a second contribution by Kachler on the compounds of the camphor group. He has accurately examined into the properties of campholic acid and some of its salts, and also into the action of bromine and phosphoric chloride on that body. The action of bromine is to oxidize the acid, forming oxycamphoric anhydride, hydrobromic acid being produced in quantity. He has also examined camphinic acid.—Weselsky follows, with an important paper on the azocompounds of resorcin, in the theoretical parts of which some most elaborate graphic formulæ are brought to life.—Liebermann and Chojnacki have again examined rufiopin, which was first obtained by Anderson from opianic acid. The authors' researches show that it belongs to the anthracene group, as by the action of zinc powder at a high temperature this hydrocarbon can be obtained from it. It therefore belongs to the same series to which the colouring matters alizarin and purpurin belong, being the next higher body in the series to purpurin.—Dittmar and Kekulé contribute a paper on an aromatic glycollic acid. The starting point for the production of this body is toluylic acid, which is acted on by bromine, and the resulting bromo-compound again acted on by barytic hydrate. The oxymethylphenylformic acid obtained forms small plates or needles as crystallised from water.—Amato has endeavoured to obtain dicyanacetic acid by treating dichloracetic ether with potassic cyanide. He has not succeeded in obtaining the acid, but seems to have produced a body which has resulted from the decomposition of dicyanacetic ether with two molecules of water.—This number contains 18 original papers, several of which, however, are translations from foreign journals.

Annalen der Chemie und Pharmacie, No. 7.—This number commences with a lengthy article on chrysanisic acid, by H. Salkowski. This acid was discovered by Cahours, in the year 1849, and has been experimented on by many chemists. Kekulé has proved that it has the constitution of a dinitrobenzoic acid, of the formula $C_6H_2(NO_2)_2(NH_2)CO_2H$. Dr. Salkowski has now made some experiments on this and its derivatives. Chrysanisic acid is obtained by treating anisol with nitric acid of 1·4 sp. gr., which converts it into nitro-anisic acid; this latter body is then treated with red fuming nitric acid, the product of which action is submitted to the action of ammonia, which yields ammonic chrysanisate. This crystallises easily, and the acid can be obtained from it in the pure state without difficulty. The author has prepared a number of the salts of this acid, which are here described in detail. By the action of hydrochloric acid and tin on chrysanisic acid, triamidobenzoic acid is produced; this acid, on heating, is decomposed into triamidobenzol and carbonic anhydride. Triamidobenzoic acid appears to possess both acid and basic properties, as it can form salts with both strong acids and bases. Both classes of salts have been prepared and are described. Thus triamidobenzoic acid forms a compound with two molecules of hydrochloric acid, and also with one of sulphuric acid. Chrysanisic acid, by the action of strong hydrochloric acid, yields trichlorobenzoic acid; and by the action of nitrous acid, dinitroparoxybenzoic acid is obtained. From this body the monethyl and diethyl derivatives can be prepared.—An interesting paper on the influence of potassium and sodium salts on fermentation, by C. Knapp, follows. He finds that both potassium and sodium salts, more especially the chlorides which he has worked with, exert a hastening influence on alcoholic fermentation, the potassium chloride being the better of the two. He also finds that a small percentage of the salt acts more vigorously than a large one.—Richard Maly contributes two papers on the colouring matter of bile, &c.; and Liebermann and Van Dorf follow with an exhaustive paper on the cochineal colouring matters.—The next paper is by Beilstein and Kohlberg, on isomerism in the benzol series. This is the fourteenth contribution from these authors on this wide subject, the present treating on cinnamic acid and metanitrobenzoic acid.

Bulletin de l'Académie Impériale des Sciences de St. Petersburg, t. xvii., No. 1.—This number contains an important paper by Prof. Kamintzin on the employment of inorganic salts as a means for studying the development of lower organisms containing chlorophyll. He studied the action of salt solutions of specified composition and various concentration on forms of algæ, chiefly *Chlorococcus infusionum* and *Protococcus viridis*. The algæ and higher cryptogams bear a higher concentration than the phanerogams. In a 3-per-cent. solution they develop vigorously; in solutions under two per cent. zoospores were produced, these again forming zoosporangia; but where the concentration was higher the development was by division into round motionless bodies. Prof. Kamintzin also studies the development of individual varieties, owing to internal causes, the external conditions remaining the same, thus extending to the lower plant forms the class of observations made by Darwin in the animal kingdom. The plasticity of various forms of algæ under the above treatment is fully shown and illustrated.—O. Grimm describes the integumental structure of one of the Crinoidea, the *Comatula mediterranea*. Certain small canals observed in an internal fibrous layer he considers to be organs of respiration, the water entering by small openings on the external surface.—There are two short papers by Dr. Levschin on the development of osseous tissue and the structure of terminal blood-vessels in the bones of the newly-born. In a paper by Dr. Gruber, the dissection of a hand having two thumbs is described, and compared with three other cases of the same kind.

SOCIETIES AND ACADEMIES

LONDON

Royal Microscopical Society, October 2.—Dr. Hudson read a paper "On *Pedalion mira*," and exhibited specimens under the society's microscopes. This curious little animal was discovered last year by Dr. Hudson near Bristol, and a figure and short description of it is given in the *Monthly Microscopical Journal* for September 1871.—The President read a paper "On the Development of the Skull of the Crow."—Dr. Woodward sent a series of photographs for exhibition, showing the resolution of Nobert's 19th band with a Tolles lens, which was not properly corrected for chromatic errors.

Academy of Natural Sciences of Philadelphia, February 27.—"On an Extinct Whale from California," by Prof. E. D. Cope. George Davidson, of the United States Coast Survey, recently presented the Museum of the Academy of Natural Sciences, the proximal portion of the left ramus of the mandible of a whalebone whale. The specimen was found in digging a well at San Diego, on the coast, in the southern part of the State, at a depth of seventy-four feet below the surface, July 27, 1871. The angle and condyle are broken from the specimen, and the distal extremity was not preserved. It possessed a coronoid process, the apex of which has been lost. The inner face is plane, somewhat convex above, behind the basis of the corodoid process. Anteriorly it becomes more convex, the surface turning inwards to the superior and inferior margins. The exterior face is convex, so that at the posterior foramen its diameter above the middle is greater than that below the middle. The inferior outline, from below the coronoid process to below the last external foramen, is straight, not decurved. It is obtuse most of this distance, but becomes narrowed at the anterior point. The superior margin is obtuse anteriorly, narrowed acute for ten inches anterior to the coronoid process; it is not truncate anteriorly. The internal foramina are large, and form a series below the upper margin, without distinct groove. The external foraminal series terminates much anterior to the interior, that is, the last external is opposite the sixth from behind of the inner row. There is no internal Meckelian groove. The Meckelian cavity of the ramus is large behind the coronoid, but small and in the upper part of the ramus at the last exterior foramen. The dental foramen is large, and above the base of the Meckelian cavity, so that its inner wall descends to the floor of the latter. Below the base of the coronoid the inferior part of the ramus is rounded, but narrower than at the dental foramen. The presence of coronoid process indicates that the present species was a finner, and allied to *Balænoptera*. Though there are no vertebræ or other elements to determine its reference to this genus or its ally *Eschrichtius*, it may be proper to refer it provisionally to the latter genus, since so many of its allies on the Atlantic coast formations have been found to be referable to it. This course is still more appropriate from the fact that the strata of tertiary age near San Diego are reported to be of miocene age, the same in which the eastern *Eschrichtii* have been found. As to its specific characters, these differ entirely from those of the latter. The ramus lacks the decurvature of most of them. In size, it approaches nearest the *E. polyporus*, Cope, and *E. priscus*, Leidy. It is much less convex externally than the latter. The exterior series of pores does not extend so far posteriorly as in *E. polyporus*, and the dental foramen has a superior position besides other differences. Size that of *E. priscus*. This whale, when living, probably attained a length of about forty feet.

PARIS

Academy of Sciences, September 23.—M. Faye, president. —The following gentlemen, members of the International Metric Commission, were present at the meeting, to which they were presented by the president:—Baron de Wrede, Sweden; M. Broch, Norway; M. de Jolly, Bavaria; MM. Stas and Maus, Belgium; General Ricci and M. Govi, Italy; Father Secchi, Pontifical States; M. Hirsch, Switzerland; M. Struve, Russia; Mr. Hilgard, U.S. America. General Fligelly, of the Austro-Hungarian Empire, member of the International Geodesical Committee, was also presented.—M. P. Favre read a note on the origin of the heat developed when the motion of a metallic disc is retarded by the influence of an electro-magnet. The author had stated in a paper read on the 11th September, 1871, that this heat is due to the "work furnished by the operator," and that the magnet expends no energy in producing it, the same effects being produced by permanent magnets which do not expend anything. He has repeated his experiments with apparatus of very great power, and finds all his statements confirmed.— —M. Yvon Villarceau then presented the elements and ephemerides of the planet 103, Hera, by M. Leveau, which was followed by the "Results of a search into the characteristics of the elementary and quartic systems," by M. H. G. Zeuthen, presented by M. Chasles. The President then presented a note of M. A. Lallemand, on the "Polarisation and Fluorescence of the Atmosphere." The author attributes the blue colour of the atmosphere to "hypochromatic fluorescence," which he explains as fluorescence accompanied by change of refrangibility due to the partial absorption of the ultra-violet rays. The next paper was by M. E. Duvillier on "A new method of preparing Chromic Acid." The author mixes into a cream 100 parts of baric chromate, and 100 parts of water, then adds 140 parts of nitric acid of 40° Reaumur, boils for 10 minutes, filters, and allows the baric nitrate to crystallise out, after which the liquid is concentrated to about the bulk of the acid employed, which removes the last traces of baric nitrate, and the chromic acid crystallises after the expulsion of the excess of nitric acid by repeated evaporations.—MM. P. Champion and H. Pellet followed with a paper of great interest, on "The Vibratory Movements produced by Explosive Compounds." The authors, starting from an observation by Mr. Abel, that whilst a small quantity of fulminating mercury exploded in gun-cotton caused its instant violent explosion, the much more violent explosive iodide of nitrogen produced no effect, proceeded to investigate these two bodies with a chromatic scale of sensitive flames, arranged as recommended by Messrs. Tyndall and Schaffgotsch, when they found that the fulminate produced effects corresponding to the notes, la, do, mi, fa, sol. The iodide of nitrogen, however, produced no effect. When the explosives were brought as close as 3·50 metres to the flames, the iodide of nitrogen affected the upper notes, while the same weight of fulminate acted on the whole gamut. The weights used were in each case ·03 grm., and it was not till the iodide of nitrogen had been increased to ·2 grm. that it produced effects equal to the fulminate.—M. Duchartre then presented a note by M. J. Duval-Jouve, "On the diaphragms and fibro-vascular nets of the leaves and stalks of certain Monocotyledons;" which was followed by a continuation of M. Stan. Meunier's paper, "Observations on the Vein Action in Meteorites;" after which M. F. Garrigou read a paper on "The alluvial gravels of the plains of the Garonne at the village of Portet, near Toulouse."—A note of M. Bonvier, presented by M. Bouley, came next, claiming priority of discovery for M. G. B. Pelletan of the "Method of removal of liquids from the closed cavities of the body by means of aspiration," described by M. J. Guérin.—M. Hartsen sent a note relative to an alkaloid extracted from Isopyrum.—M. Dumas presented an analysis of the documents sent to the Phylloxera Commission by two of its delegates, MM. Duclaux and Maxime Cornu; and a note from M. J. Capello, of Lisbon, on the aspect of the sun about the 9th of August closed the meeting.

BOOKS RECEIVED.

ENGLISH.—Elementary Geology: J. C. Ward (Trübner and Co.).—An Elementary Treatise on Geometrical Optics: W. S. Aldis (Deighton and Bell).—Elementary Treatise on Natural Philosophy: Deschanel. Part 4 (Blackie and Sons).

AMERICAN.—Papers relating to the Transit of Venus in 1874, prepared under the direction of the Commission authorised by Congress. Part 1.

FORRIGN.—Eerste Vervolg Catalogus der Bibliotheek en Catalogus der Maleische, Javaansche en Kawi handschriften van het Bataviaasch Genootschap van Kunsten en Wetenschappen (Bruining, Batavia).—Tidschrift von Indische Taal- Land- en Volkenkunde: Stortenbeken en Michielsen, Deel xviii., Zesde Serie, Deel i., Aflevering 3 en 4; Deel xx., Zenende Serie, Deel i., Aflevering 3.—(Through Williams and Norgate.)—Der Wirbelsturme, Tornados u. Wettersäulen in der Atmosphäre: Dr. T. Reye.—Pathologische Histologie der Laftwege u. der Lunge: Dr. A. Thierfelder.

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