THURSDAY, OCTOBER 17, 1872

CANON KINGSLEY ON PHYSIOLOGICAL TRAINING

THE recent address of Canon Kingsley, as President of the Birmingham and Midland Institute, has struck a key-note which has been widely responded to. Not that he has said anything new; but truths are none the less true for being world-old. It is something to find a man of Mr. Kingsley's popularity and influence insisting on the need of physical and scientific culture; it is more that the utterance should be made to a crowded audience at one of our great centres of industry; it is still more that our daily and weekly papers should at length discern the importance of that which a select few have long been preaching in vain. We can, however, only refer to some of the more important points on which the lecturer touched, referring our readers to the report *in extenso*, in the *Birmingham Daily Post*.

The following admirable advice was given to the younger students among the assembly:—

"Let me warn you that none of you will profit by any lectures, unless you study at home the text-books recommended by the lecturer. You will be otherwise little wiser than a man who should purpose to learn arithmetic by listening to talk about the proportion of numbers without doing sums himself. You will not teach yourselves even the attitude necessary for your subject—the attitude of mind, by which the facts were discovered, by which they must be understood, by which they must be turned to use. You will not acquire, by mere lecture-hearing, the inductive habit of mind which arranges and judges of facts. Still less, therefore, will you acquire the deductive habit of mind which makes use of facts practically after they have been arranged and judged; and the lecturer will be to you but a sort of singer, a player upon a fiddle, who makes for you pleasant and interesting noises for a while, producing mere impressions which never sink into the intellect, but merely touch the emotions, to run off them at the first distraction, like water off a duck's back. Therefore, remember this for yourselves in this age of periodical literature and literature made easy: we are all too apt to forget that what we did you must do, if you wish to be as good men as we, viz., work for yourselves, as we did; that good lectures, like good reviews, are not meant to see for you, but to teach you to use your own eyes; and those you must use at home in hard study, personal study, continuous study—and study, too, rather of one subject than of many subjects, in order that, by learning how to learn one thing thoroughly, you may learn how to learn anything and everything else in its turn."

After referring to the evils of war in producing the exactly opposite results to those brought about by the process of Natural Selection, by the Destruction of the Fittest, the lecturer thus proceeds:—

"Peace, prosperous, civilised, humane, such as we enjoy now, is fraught with the very same dangers. In the first place tens of thousands—who knows it not?—lead sedentary lives, stooping, asphyxiated, employing as small a fraction of their bodies as of their minds; and that such a life must tell upon their offspring—it may be for generations to come—what medical man does not know full well? And all this in dwellings, workshops, mines, and what not, where the influences, the very atmosphere of which tend to unhealth, and not to health; to drunkenness as a solace under the feeling of unhealth and all unhealth's depressing influences. But now—and this is one of the most fearful problems with which modern civilisation has to deal—we interfere with natural selection from conscientious care of life just as much as war itself does. War kills the most fit to live. We spend vast energies in saving alive those who, looking at them from a merely physical point of view, are most fit to die. Everything which tends to make it more easy to live—every sanitary reform, prevention of pestilence, medical discovery, amelioration of climate, drainage of soil, improvement in dwelling-houses, workhouses, prisons, every reformatory school, every hospital, every cure of drunkenness, every influence, in short, which has (so I am told) increased the average length of life in these islands since the first establishment of life insurance offices, 150 years ago, by nearly one-third—every influence of this kind, I say, saves persons alive who would otherwise have died; and the great majority of these persons, even in surgical cases and cases of zymotic disease, will be those of the least resisting power, the weaklier; thus preserved to produce, in their turn, a weaklier progeny. And what will you do with it? Do I say that we ought not to save them if we can? God forbid! The weakling, the diseased—whether infant or adult—is there on earth a British citizen! no more responsible for its own weakliness than for its own existence. Society—that is, in plain English, you and I and our ancestors—are responsible for both; and we must fulfil the duty, and keep the weakly person in life, and if we can, heal, strengthen, develop to the utmost, and make the best of that which 'Fate and our own deservings' have given us to deal with."

The practical application of this teaching was then pointed out:—

"And so as to the laws of personal health;—enough, and more than enough, is known already to be applied safely and easily by any adult, however unlearned, to the preservation, not only of his own health, but of that of his children; the value of healthy habitations, of personal cleanliness, of pure air, pure water, of various kinds of food, as tending to make bone, fat, or muscle, provided only that the food be unadulterated—and you might stop the adulteration in Birmingham in a month or week if you chose. . . . Have you not here, ready made to your hands, an engine for extending sound knowledge of the laws of health? In a great manufacturing district, which specially needs those laws to be known and obeyed, you have this Institution always teaching physical science. It would not, therefore, go beyond its province in teaching the physical science of health. It teaches, happily, a people specially intelligent, specially accustomed by their businesses to the application of scientific laws. To them, therefore, the application of any fresh physical laws would have nothing strange in it. They have already, I doubt not, that inductive habit of mind which is the groundwork of all rational understanding or action. They would not turn the deaf or contemptuous ear with which the stupid, the savage, the superstitious, receive the revelations of Nature's mysteries. Surely, with such a people to work upon, it were well worth your while to expand your classes of physiology, and give one or more of them a practical turn in the direction of practical health. Your Animal Physiology Class is, I doubt not, a sound and useful one. It cannot well be otherwise, while its text-book is Prof. Huxley's Elementary Lessons; and I am glad to see that your learned lecturer is about to confine himself, for the present at least, to the physiology of the animal most abundant in, and most important to, Birmingham, namely, man. Twenty lectures are announced in your programme dealing with the tissues of the body, their structure and uses, circulation of the blood, respiration, chemical changes in air respired, amount breathed, digestion, nature of food, absorption, secretion, functions of the nervous system. Now, this is as it should be. It is admirable. Teaching of this kind ought, and will in some more civilised society, be held as a necessary element in the school course of every child; just as important as reading, writing, and arithmetic; and is the most necessary and most important branch of technical education, namely, the act of keeping yourselves alive and well. But you can hardly stop short there. After you have taught the conditions of health, should you not teach also somewhat of the causes of disease—of those diseases, especially, which tend to lower wholesale the physical condition of dwellers in towns, exposed to the unhealthy influences of an artificial life? Should you not teach young men and women something of the causes of pestilence, of zymotic disease, and of scrofula, consumption, cerebral derangement, dipsomania, and such like? Should you not show them the value of pure air, pure water, unadulterated food, wholesome dwellings? We want set up in the centre of large towns—it will not come yet, but it will come some day—a statue to the goddess of purity. Is there one of them, man or woman, who would not be the safer himself and the more useful to his neighbours if he had acquired some sound notions about those questions of drainage on which their lives and the lives of their children may any day depend. I say women as well as men; ay, women even more than men. For it is the women who have the ordering of the household, the women who have the bringing up of the children. And if any say, as they have a right to say, 'But these are subjects which can hardly be taught to young women in public lectures,' I reply, 'Of course, unless they are taught by women—women, of course, duly educated and legally qualified.' Let them tell young women what every young woman ought to know, and what her parents will very properly object to her hearing from men, or in the company of men. This is one of the main reasons why I have for twenty years past, and shall as long as I live, advocated the training of ladies for the medical profession. And now, I am seeing the common sense of England, and, indeed, of every civilised nation, coming round to that which seemed to me, when I first conceived of it, a dream too chimerical to be cherished, save in secret; and I trust soon to see a supply of lady-doctors, sufficient to fulfil that old dream of mine, and to establish in every great town of these islands health classes for women.

"Now why should not your Institute, which has taken the initiative in so many useful enterprises, take the initiative in this too? It is already a school of many things. Why should it not be also a school of health—a school of sanitary science? Why should it not send forth year by year more and more young men and women, taught not only to take care of their own health and that of their families, but to exercise moral influence in the same direction over their fellow-citizens—to advocate as one simple, and yet most necessary and important, good deed, the teaching of the laws of health in every school, from the highest to the most elementary? Do that. Send forth healthy pupils yearly, champions in the battle against dirt and drunkenness, disease and death, and you will raise a yet prouder title to the gratitude of your fellow-countrymen than you have earned already by your scientific zeal and your noble liberality. There are those who may answer—or rather there would have been those who would certainly have answered, five and twenty years ago, before the so-called materialism of advanced science had taught us some practical wisdom about education—'And if it were so, what matter? Mind makes the man, not body. We do not want our children to be stupid giants and bravos, but clean, able, highly-educated, however delicately Providence or the laws of Nature may have been pleased to make them. Let them overstrain their brains a little, let them contract their chests, and injure their digestion and their eyes, by sitting at desks and poring over books. Intellect is what we want, and intellect makes money; intellect rules the world. I would rather see my son a genius than an athlete.' And so would I. But what if for want of obeying the laws of Nature you got neither genius nor athlete, but generally an incapable, unhappy personage? Without healthy bodies you will not, in the long run, get healthy intellects. . . Wherever you have a population generally weakly, stunted, scrofulous, you will find in them a corresponding type of brain which cannot be trusted to do good work. It may be very active, it may be very quick in catching up new and grand ideas—all the more quick on account of its own secret malaise and self-discontent; but will be spasmodic, irritable, hysterical. It will be apt to mistake capacity of talk for capacity of action, excitement for earnestness, virulence for force, and cruelty for justice. It will lose manful independence, individuality, originality, and when men act they will act from the consciousness of personal weakness, leaning against each other, swaying about in mobs and masses."

We sincerely hope that the publicity which has been given by the public press to this address by Canon Kingsley will be the means of awakening the minds of many to the vital importance of that scientific training which he, in common with every enlightened mind, advocates.

MARTIN ON MICROSCOPIC MOUNTING

A Manual of Microscopic Mounting. By J. H. Martin. (J. and A. Churchill.)

SCIENCE in this country is certainly under great obligations to *amateurs*, or *dilettanti* as they are more correctly called. The fact is there are in Great Britain but a very few men of science, that is to say, men professionally devoted to scientific careers, as compared with Germany and even France—we are very poor in this source of power. Germany has a host of universities and high-schools in each one of which there are more men whose lives are definitely told off to the cultivation of science, than there are in our greatest and richest seats of learning. Dilettantism is the fashion of some branches of science in this country, and under it they have thriven in a way of which we may be to some extent proud; but which seems likely enough to impede greatly their more systematic cultivation. Geology has perhaps more than any science benefited by the patronage of *dilettanti*; but it is not difficult to foresee the time when its problems will have become too arduous for any but trained and devoted specialists to make any way with them. The same is to a less extent true for the biological sciences, in which, besides the enthusiastic field-naturalists, the members of the medical profession have been conspicuous as *dilettanti* explorers. At the time when (some five and twenty years ago) the microscope was first brought to a state of efficiency in this country, a perfect army of amateurs entered the fields of animal and vegetable histology, equipped with the beautiful and costly instrument, and brought to light a considerable number of important facts bearing on the structure of tissues and the minuter forms of life. This was not the case on the Continent, the costliness of the instrument, in addition to the other causes which make Englishmen remarkable as scientific *dilettanti*, tending to limit the movement to this country. The taste for amusement with the microscope has by no means diminished of late years, the sales of instruments by English makers being something astonishing in point of number and implied outlay. But it is a fact—for which we can most positively vouch—that the good work done at the present time in England with the microscope has fallen very far behind its original proportion to the number of instruments in use. In fact we have in the history of English research with the microscope, a typical case of the breaking down of dilettantism. Nearly all the discoveries easy to hand, which could be made by half-an-hour's pleasant peeping through a good microscope have been made, and the numerous observers formerly urged on by success have now become reduced to mere collectors of diatoms and mounters of fleas. On the other hand, in Germany, an efficient microscope was produced somewhat later than in this country, on a different system and at a far less cost. It was not taken up by men of leisure and means, nor were the makers tempted to produce the most elaborate and costly mechanical contrivances for no practical end but their own profit. The microscope in Germany fell into the hands of the professed students of science in the universities, and in consequence the art of applying this instrument to the study of structure has steadily advanced in that country, until not only are all the important observations which are made with the microscope made in German laboratories, or by those who have studied in them; but the whole art or "technic" of microscopy has become a German one. When we find that it is necessary, for some purposes, to watch a single cell for twelve hours or more consecutively, and that three or four months' daily labour is not considered too much to devote to advancing one small step in the knowledge of such a matter as the nerve branches which go to the glands in a frog's tongue, we are not surprised that the *dilettanti* are no longer of service in the progress of researches with the microscope. Thorough and single-purposed men are required for such work; in short, "men of science," supported by special institutions.

It is then with very mixed feelings that we contemplate Mr. Martin's book on Microscopic Mounting. It is of about as much use for scientific purposes as would be an alchemist's guide-book in a modern chemical laboratory. Foreigners who do not know of the immense number of microscopes annually sold in this country as toys, will wonder who on earth can make any use of it. Microscopic mounting is a proceeding which bears about the same relation to the genuine microscopic study of an organism, as enclosing a "subject" in its coffin does to human anatomy. The object which is aimed at by the modern student of histology is not to "mount" a pretty specimen, but to apply such staining, clarifying, coagulating reagents, and such methods of disruption, slicing, hardening, or softening, as will enable him to discriminate, describe, and draw structure; or, it may be, so to arrange the somewhat restrictive conditions of microscopical examination as may enable him to observe with the highest powers the tissues of organisms in their *living* state. He does not care a dump for "mounting," and if he has in the course of his work prepared some hundred or two preparations of an organ or organism which he is investigating, the preparations are usually thrown away when the problem under investigation is solved, or lie for years undisturbed in the catacombs of some cabinet. Mr. Martin is of no assistance whatever in all that relates to the use of reagents or adjuncts to observation with the microscope. He is evidently quite ignorant of German; he gives a number of receipts taken from a variety of antiquated English sources; others he takes without acknowledgment from the "Quarterly Journal of Microscopical Science;" see, for example, the paragraph on staining tissues, p. 144, which can only serve to mislead. Some, of course, amongst Mr. Martin's instructions are correct; but we feel convinced that he has not made trial of even the few methods which he has imperfectly described; and we decidedly object to his assuming the office of a guide, when it is but a case of the blind leading the blind.

Still, Mr. Martin's book may be looked at as an interesting specimen of the phase which English *dilettante* microscopy has now reached. Had the author been a little more careful in confining himself to what he really understood as a diligent mounter of microscopic objects, his volume would have had a genuine antiquarian interest, and would have perhaps been useful; indeed, it may even now in some ways be so to those who take a view of the microscope similar to his own.

It would hardly have been worth while expending so many words on a book in itself of so little significance, had not there been two conditions in existence which, if passed by without remark, may have some consequences which had better be avoided. Firstly, the number of persons, medical students and others, now entering on the serious study of histology, and the use of the microscope as an instrument of scientific research, is increasing. They want books to supplement the efforts of teachers in putting them into the way of working and explaining to them—if we may so say—the most useful "dodges." Secondly, there are other books besides Mr. Martin's which profess to give instruction on microscopic manipulation, and are all *worthless*. The students may, in their innocence, be led to purchase such books. We wish them to avoid making this mistake. There is no satisfactory book in English on the subject. Beale's is the best, but too large, and not sufficiently complete excepting as to his own methods. Frey's book, which exists in both a French and a German form, is the best foreign guide to microscopic *Technik*.

OUR BOOK SHELF

Magnetism and Deviation of the Compass. For the use of Students in Navigation and Science Schools. By John Merrifield, LL.D., F.R.A.S. (London: Longmans and Co.)

The Admiralty Manual of Compass Deviation with its auxiliary Elemenatry Manual would, after some lapse of time, appear to have been turned to good account by teachers of navigation. The small volume under review is one of a plentiful supply which appears to be now issuing from the press on a subject of vast importance to seamen of the present generation; and as such is deserving of notice.

It contains useful information of an elementary kind, although this information is not presented either in the practical form or exact and mathematical arrangement of the two manuals we have noticed as the fountain heads of the science of magnetism as applied to iron ships and their compasses.

It is to be regretted that in a subject where clearness and precision are essentials to teaching, Dr. Merrifield should have written occasionally with looseness and inaccuracy; for example, at p. 52 we find "Vertical iron at the same place will produce the same deviation in whatever direction the ship's head may be, because a vertical line makes always the same angle at the same place with the line of force." There is confusion of cause and effect here—the deviation is not the same in whatever direction the ship's head may be, although the force remains constant or nearly so—and these are important features for the student to realise.

Notwithstanding, however, these shortcomings, Dr. Merrifield's "small manual" may in the main be received as an orthodox production, and will tend to divert the attention of his students from some singular statements and conceptions relating to the deviation of the compass on board ship and its compensation, to be found at pp. 20-23 of his Navigation and Nautical Astronomy published conjointly with H. Evers in 1868.

We hope to see manuals of this smaller class emanating from seamen, who, possessed of the knowledge of the exact requirements in the practice of their calling, can extract from original sources, and simplify the main points in the various divisions of the subject.

LETTERS TO THE EDITOR

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

Solar Spectroscopic Observations

I HAVE just seen Herschel's letter to you in NATURE of October 3, and am induced to address you, lest his remarks on Indian Climate should make difficulties in respect to the British Association's proposal for a physical observatory for solar observation.

I do not think Captain Herschel has been in England since the Eclipse of 1868, and consequently he cannot speak from experience of the English climate. It is beyond all doubt that from some cause (commonly believed to be haze) there are really very few days when the protuberances can be studied in England. Herschel's letter contains evidence that that cause, whatever it be, is absent in India. We need not go further; we have the two facts (1) that it is impossible in England, with great telescopic power and great dispersion, to see the prominence lines regularly; (2) that it is possible to do so in India, even in the plains at a bad season. The result seems to be that solar investigations should be pursued in India systematically.

I may add that the facility of seeing these things, and the probability that spectroscopic inquiries into the celestial bodies would have been more successful in the earlier stages had there then been any observers in India, are to my mind a strong argument for now establishing in India, and on a permanent footing, an observatory, whose speciality shall be "Researches on the Physics of the Sun and Planets," whether by the spectroscope, or vision, or photography. When the proposal of the British Association is made formally to the Government by the Council, it will, I trust, take this form. There is no such institution now in the British dominions, and when one is established, it should be in the Tropics somewhere, and as systematically devoted to physical researches as Greenwich has been to the moon.

The Director might, probably would, as at Greenwich, in time attach other investigations; but these researches should be his primal object; and, if they were made so, there is no reason why work as standard and as useful should not result.

October 4 J. F. TENNANT

Consciousness and Volition

THE question raised by Mr. Bennett in last week's NATURE is of great importance, and of no small difficulty. During a visit to the late Sir William Hamilton in 1855, this subject came up for discussion. Sir William was then engaged on his edition of the works of Dugald Stewart. I called his special attention to Stewart's doctrine regarding the operation of Will in acts which are usually ascribed to Habit. Stewart asserts that all habitual actions are really voluntary. As he had no acquaintance with the modern doctrine of "latent mental modifications," he would naturally take for granted that there can be neither a volition nor any other act of mind without accompanying consciousness. He accounted for the non-remembrance of that consciousness by the extreme rapidity of the volitional action. (Collected Works, vol. ii. chap. ii.) To this Sir William objected. He went on to show that in many cases an act, or even a long series of acts, originally voluntary, have ceased to be so. The habit or habitude, which is a mental tendency, though not a power, generated by custom, supplies the place of volition. In illustration, he referred particularly to the well-known fact that in India soldiers will march long distances when they are asleep. Now, it seems to me that this decides Mr. Bennett's question. Here we have regulated action, determined, not by volition, but by habit. Sir William, however, failed to meet all my difficulties, because, as I afterwards saw, of his unsatisfactory theory of causation. He so frequently confounded conditions with causes. With him a cause denoted anything without which an effect could not be; hence his doctrine of con-causes, a plurality of causes for each effect. Thus, when I will to move my hand, and the movement follows, Sir William would call the volition *one* cause of the movement, whereas it is merely a condition. It is remarkable that he should fall into this error since he rejected Biran's doctrine regarding the efficiency of volition. In a subsequent conversation we discussed the points of similarity and the points of difference between Habits and Instincts. It would, however, be trespassing on your space to give the details.

I will only add that an "unconscious volition" in the sense intended by Mr. Bennett is not possible. Dr. Carpenter's expresion "unconscious cerebration" I regard as unfortunate, since it appears to rest on the assumption of the essential identity of mental, vital, and physical powers. Mr. Bennett will find many valuable observations on the nature and conditions of habitual acts in Hamilton's lectures on "Metaphysics," Morell's "Outlines of Mental Philosophy" (published in 1862), and Sir Henry Holland's "Mental Physiology."

JOHN MOORE

Stamford House, Sale, near Manchester, Oct. 14

The Solar Spectrum

UPON reading the communication from Capt. Herschel in your number for October 3, upon the solar spectrum, I seem to remember a letter from a correspondent being published some year or more ago in your pages, in which it was stated the writer had seen the bright lines near the sun's limb with one of Browning's direct vision prism spectroscopes, the instrument being placed on the back of a swing looking-glass as a stand. The dispersion of this instrument would be probably rather more than that of one angular prism. I am bound to say that I have been unable myself, up to the present time, to do more than see a bright line near D, superposed on the solar spectrum, with such an instrument as, however, for other purposes, is a most convenient and sufficiently powerful one.

To my own I have added three small wedge-shaped pointers cut out of thin brass, and fixed in the eye-piece, while the slit-plate, and consequently the spectrum itself, is drawn across the field by a micrometer screw having a range of about 600 divisions between its starting point near A and G at the other end of the spectrum. In this way a bright line (say the auroral one) may be brought upon one of the pointers, and its distance from D, in a salted spirit-lamp flame, at once accurately measured and mapped down; and if the pointer is again brought on the line after the observation, it may be verified by the position of the pointer next day upon the solar spectrum itself.

It occurred to me the other evening to try the effect of a V-shaped slit, and it seems to me to have some advantages. The lower ends of bright lines being brought to a fine point, are more easily positioned on a scale or pointer, while the tapering of faint or nebulous lines or bands enables their relative intensity to be more easily compared. My experiment was a rough one, and with a home-made slit; but for working purposes, by a sliding plate a slit might be contrived of a V shape, whose width and length would be altered at pleasure; and it would, I think, for some observations give good results.

Guildford, Oct. 7 J. RAND CAPRON

A Day Aurora

A CONTROVERSY was carried on in your columns about a year ago as to the possibility of an aurora being seen during the day time. A recent communication from Padre Secchi to the French

Academy of Sciences will be found of interest as bearing on this question. Writing from Rome on the 27th of August, he says (*Comptes Rendus*, p. 613):—"On the 15th of this month we had an Aurora Borealis by day, at ten o'clock in the morning up to midday. The magnetometers were greatly disturbed, and in the heavens at half-past ten appeared an arch of light cirrus clouds, stretching from N.N.W. to N.E., and crowned along the whole of its contour by numerous and fantastic rays (*jets filamenteux*). The forms of these rays so perfectly resembled those of the solar protuberances that some of the drawings of them might easily be mistaken for drawings of solar protuberances even by people well accustomed to these observations."

Merton College, Oxford J. P. EARWAKER

Meteor

LAST night, Oct. 9-10, about midnight, G.M.T. a meteor was seen by my wife in the S., considered by her to rival the brightness of Venus, and describing a path which was so carefully sketched by her immediately afterwards as to form a possible basis of comparison; and which therefore may be thought worthy of insertion in NATURE. It seems to have become visible near ζ Ceti, probably rather *nf* that star (which, however, was not noticed by her through a dewed window-pane), and to have passed with a slow motion and a yellowish light, in a path somewhat convex towards the zenith, in the direction of β Ceti, before reaching which it vanished. For about three-fifths of its course it preserved the same aspect, as of a ball of light with sparklings round it, and some appearance of a train; but in its further progress it seemed to waste away to extinction.

T. W. WEBB

Hardwick Vicarage, Herefordshire; according to Ordnance Map, long. W. 3h. 4m. 23s., lat. N. 52° 5′ 20″.

Fossil Oyster

I HAVE recently noticed a fossil oyster, in what Sir C. Lyell calls the Lower Miocene, or Hampstead beds. Can you, or any of your readers inform me if it has been noticed before. I can find no mention of it, in any work within my reach. I have been a subscriber, from your first number; and have observed the kind notice you have extended to other inquirers, and have thus been emboldened to trouble you. INQUIRER

N.B.—I have no pretensions to science, or any scientific acquaintance, being merely a solitary observer.

AN ELECTRICAL BAROGRAPH

I HAVE recently designed a barograph, a brief account of which may be interesting to your readers. The advantages claimed are:—

That the record may be seen as it is going on.

That it is quite as, if not more sensitive than, the photographic barograph, and the scale is larger.

That no time is lost preparing the paper, printed forms answering the purpose.

That the first cost and cost of working are both much less than in the photo-barograph.

A photograph has been taken which shows the instrument in working order, with part of a day's record shown on the cylinder.*

The cylinder is ten inches long, and eight inches in diameter, allowing for one inch per hour of paper.

The clock, or governor, is connected by a bar to a movable inclined plane, this is again connected by a bar to the long wire parallelogram which carries the pen, and the clock, by means of an eccentric, causes the inclined plane, and with it of course the pen frame, to move backwards and forwards once every minute. The wire frame is guided by four brass friction wheels, attached to a brass frame having motion up and down only; under it are the coils of an electro-magnet, the armature of which is attached to the brass frame. So long as no electricity passes through the coils the brass frame is thrown up by a small spring high enough to lift the pen off the paper.

* A photograph and section were obligingly forwarded by the author with his description.

The barometer tube is an ordinary glass one 0·58 in diameter, and is fixed firmly to the case. Its cistern is a small glass one, one inch in diameter, and cemented to a brass arm hinged to the left side of the case, and which allows it perfectly free motion up and down, but not sideways. From this cistern projects a very light arm, also hinged, and bent at the end so as to extend over the inclined plane. One wire of the battery is attached to the cistern arm, and the other, after passing round the magnet, to the inclined plane. As soon, then, as these two parts touch, the electro-magnet brings down the brass frame, and with it the pen, on to the papers which at once begins to mark, and continues to do so until the motion of the clock draws the inclined plane from the cistern arm, and so breaks the contact; the pen remains off the paper until, by the motion of the clock, the inclined plane is brought to touch the projecting cistern arm, when the pen at once begins to write. As the barometer, when the pressure increases, must draw the mercury for its increased height from the floating cistern, the cistern becomes lighter, and rises with it, and the smallest motion may be made sensible by altering the inclination of the moving inclined plane. The accuracy of the motion of this plane is secured by making it work on two fine steel points—the same motion, in fact, as that given to the cutter of a dividing engine. The cistern floats in a reservoir of mercury.

The pen is a syphon pen, supplied with *thin* ordinary writing ink. H. C. RUSSELL

Sydney Observatory, Aug. 10

BEAUFORT'S WIND SCALE AND THE BOARD OF TRADE*

THE Board of Trade have recently issued instructions to Receivers of Wreck and Officers of Coastguard, with reference to Beaufort's Wind Scale, so that one uniform construction should, as far as possible, be placed upon the wind scale by them. In the Circular the following passage occurs:—

"The Board of Trade are led to think that different constructions are placed by different persons upon the scale known as Beaufort's scale. In illustration, it may be remarked that the higher forces, 11 and 12, are, as the Board learn from the Meteorological Committee, scarcely, if ever, reached in the British Isles. Force 12, which is intended to represent a West India hurricane, the velocity of which is 80 miles per hour and upwards, has been reached only twice in four years on the coasts of the United Kingdom; notwithstanding high winds prevailing at the time of a wreck are frequently described by the ships' officers as storms or hurricanes."

It is here taken for granted that the positions of the anemometers of the Meteorological Committee are such as to record observations of wind fairly comparable with those felt at sea; and also that the anemometers are constructed to record those velocities of the wind which are applicable to the case in hand.

It is not stated how the two instances of velocity of 80 per hour and upwards were ascertained. Since, however, the space traversed or recorded by the anemometers at the observatories of the Meteorological Committee can scarcely be measured for a shorter period of time than 15 minutes, it may be assumed that on two occasions, and only on two occasions during four years, have the anemometers been noted to record a velocity of 20 miles or upwards in 15 minutes—that is, a velocity at the rate of 80 miles an hour or upwards. If the tracings of the Hemispherical Cup Anemometer could be read off for so short a period as five minutes, many instances of 80 miles an hour, and even several velocities of 100 miles an hour and upwards, could be taken from the records of these four

* See Circular, No. 558.

years in the Meteorological Office. Indeed, a careful inspection of the lines of wind velocity published in the Committee's Quarterly Reports renders this supposition extremely probable.

During high winds it is well known that the wind does not blow with a uniformly high velocity, but that there occur frequent gusts of comparatively brief duration, many of the heaviest being, indeed, all but instantaneous. Thus the anemometer may indicate a velocity at the rate of no more than 60 or 70 miles an hour, but during the time there may have occurred 20 or 30 sudden gusts quite equal to the Force 12 of Beaufort's scale. Now, it is these repeated heavy gusts which cup-anemometers do not record that sailors have to provide against in the management of their ships. Hence it happens that while at observatories on land, provided only with cup-, anemometers, no greater velocities than 60 or 70 miles an hour can be noted, in ships at sea, what the seaman has actually to deal with are velocities of 80 or 100 miles an hour. He accordingly enters these high pressures in his log.

It is evident that the Board of Trade are not in a position to give the assistance to sailors which they are seeking to give, till pressure-anemometers have been established at their observatories.

The Circular contains this very judicious remark:—"The Board desire to impress upon Receivers and Officers employed in reporting casualties, that the direction and force of the wind at the time of a casualty should be ascertained as accurately as possible, and that therefore these particulars should not be inserted without every precaution being taken to insure that they are in accordance with fact." It only remains that the Board of Trade furnish each Receiver and Officer with a simple pressure-anemometer, having a scale, 0 to 12, agreeing as nearly as possible with Beaufort's scale, and so constructed as to show the pressure at the time of observation, and to register maximum pressures, so that the officials may be put in a position to carry out the instructions of the Board.

SCIENCE AT OXFORD AND CAMBRIDGE

THE following courses of lectures are arranged for the ensuing term at the University of Oxford:—

Mr. R. B. Clifton, Professor of Experimental Philosophy, on "Optical Instruments and Physical Optics;" beginning Saturday, the 19th of October. The Physical Laboratory of the University will be open daily for instruction in practical physics from 10 to 4 o'clock on and after Thursday, the 17th of October.

Mr. J. O. Westwood, Hope Professor of Zoology, proposes to form a class for the study of the structure and classification of articulated animals.

Mr. W. Odling, Professor of Chemistry, on "The Succession of Chemical Ideas;" beginning Thursday, October 17. There will also be an explanatory and catechetical lecture on Tuesdays at 11 o'clock, to commence on Tuesday, October 22. The laboratory of the University will be open daily for instruction in practical chemistry from 9 A.M. to 3 P.M. on and after Monday, October 14. In addition to this two courses of instruction will be given in the laboratory—a course on the methods of quantitative analysis, and a course of elementary practical instruction in chemical manipulation, intended for those commencing the study of chemistry.

Mr. G. Rolleston, Linacre Professor of Anatomy and Physiology, on "Human Anatomy and Physiology, with special reference to Ethnology;" beginning Friday, the 18th of October. The work-rooms in the Anatomical Department are open daily from 9 A.M. to 5 P.M. for practical instruction, under the superintendence of Mr. Charles Robertson, the Demonstrator of Anatomy, and Mr. S. J. Sharkey, of Jesus College. A special class will be formed for instruction in Practical Microscopy. Mr. E. Ray Lankester, of Exeter College, will, as Deputy of the Linacre Professor, give a course of lectures on "The General Classification of the Animal Kingdom," beginning on the 19th of October.

Mr. J. Phillips, Professor of Geology, on "The Successive Conditions of Land and Sea, taken in the order of Geological Time;" beginning Monday, October 28.

The following are also announced in connection with Trinity, St. John's, and Sidney Sussex Colleges, Cambridge:—

On "Electricity and Magnetism (for the Natural Sciences Tripos), by Mr. Trotter, Trinity, commencing Wednesday, Oct. 16. On Chemistry, by Mr. Main, St. John's, in St. John's College Laboratory, commencing Thursday, Oct. 17. Attendance on these lectures is recognised by the University for the Certificate required by Medical Students previous to admission for the first examination for the degree of M.B. Instruction in Practical Chemistry will also be given. On Palæontology (the Protozoa and Cœlenterata), by Mr. Bonney, St. John's, commencing Thursday, Oct. 17. On Geology, (for the Natural Sciences Tripos. Preliminary matter and Petrology), by Mr. Bonney, St. John's, commencing Wednesday, Oct 16. A course on Physical Geology will be given in the Lent Term, and on Stratigraphical Geology in the Easter Term. On Botany (for the Natural Sciences Tripos), by Mr. Hicks, Sidney, beginning on Thursday, Oct. 17. The Lectures during this term will be on the Morphology of Phanerogamia. Mr. Hicks will also give examination papers in Botany to candidates for the next Natural Sciences Tripos, beginning Oct. 21. On the Physiology of the Organs of Sense, by Dr. M. Foster, F.R.S.; and a Course of Practical Physiology. The days, hours, and dates of commencement of these two courses will be announced shortly.

AMERICAN PREPARATIONS FOR THE FORTHCOMING TRANSIT OF VENUS

AMID the violent political agitation and the inevitable social commotion of the United States, one would imagine, judging from our own case, that neither the American Government nor the American people had any time or funds to devote to scientific objects of apparently remote utilitarian interest. That this is not the case every regular reader of this periodical must be aware, for seldom does a week pass but we have occasion to notice some scientific expedition fitted out by Government funds, or the meeting of some well-organised and efficient scientific association, or the report of work done at one of the numerous scientific schools with which the country abounds, or the results of an expensive scientific inquiry or scientific experiment; in short, the Americans seem to think it their interest and duty, as it is their inclination, to give substantial encouragement to scientific research and the spread of scientific culture and knowledge. Verily they know how to do these things better in America than in England; but, indeed, of what foreign country can this not be said? This cannot be better seen than in the action taken by the U.S. Government in reference to the forthcoming Transit of Venus.

In March 1871 Congress, instead of appointing one irresponsible official to organise all the preparations necessary for the observation of one of the rarest and most important astronomical phenomena, authorised the appointment of a Commission "to expend such appropriations as might be made by Congress for the observations of the coming Transit of Venus." This Commission is composed of Rear-Admiral B. F. Sands, Superintendent U.S. Naval Observatory; Prof. Joseph Henry, LL.D., President National Academy of Sciences; Prof. Benjamin Peirce, LL.D., Superintendent U.S. Coast Survey; and two Professors of Mathematics of the Naval Observatory, viz., Profs. Simon Newcomb and William Harkness. These gentlemen are all thoroughly qualified, both from their attainments and position, to perform the important and critical duties devolving upon them; and from their varied experience and knowledge, as well as from their differences of mental constitution and vision, they are more likely to do their work exhaustively and with thorough efficiency, than if their task had been committed to the absolute care of a single individual, no matter how well qualified he might have been. "In the multitude of counsellors there is wisdom."

The Commission have set about their work in a thorough and business-like way, and seem determined that America shall have no rival in the perfection of the preparations organised for making the most of the momentous astronomical event. They, however, do not grudge to give the world generally the benefit of whatever important conclusions may result from their inquiries and experiments. At a meeting of the Commission in July last, it was resolved to print such papers relating to the subject as might be of sufficient interest and importance. The first collection of these papers lies before us, and we shall endeavour to lay before our readers the gist of its contents.

The first article is a letter from Rear-Admiral Sands to the Secretary of the Navy, suggesting the advisability of asking Congress to appropriate the necessary funds for fitting out expeditions to observe the transit. Congress, it appears, in 1871 had made a small preliminary appropriation of 2,000 dols., but the Commission having decided that the total cost of carrying out the work in a fitting manner would be 150,000 dols., to be expended in three annual instalments, Rear-Admiral Sands requested the Secretary to procure for them the first instalment of 50,000 dols., which were to be almost entirely spent in the construction of instruments. Judging from the indorsement of the Secretary, it seems certain that the request of the Commission has been granted.

The next letter is from Rear-Admiral Sands to Mr. Lewis, Mr. Rutherfurd requesting his advice respecting the best method of applying photography to the determination of the relative positions of Venus and the sun during the transit. Mr. Rutherfurd replies by giving a detailed description of the method of solar photography employed in his own observatory, describing the form of photographic instrument he considers best adapted for the observation of the transit. He gives directions as to the construction and manipulation of the objective, the tube and focus, and the camera-box, which seem to be in all essential respects similar to those which have hitherto been found most efficient elsewhere. His opinion as to the best form of photographic instrument is, however, worth quoting. Mr. Rutherfurd says (p. 13):—

"If the whole matter of ordering instruments for the photographing of the transit of Venus were in my control, with my present lights, I should have an achromatic objective of 5in. aperture, and 70in. focus, in a cell which would allow of the application in front of it of a lens of flint glass of such curves as would shorten the focal distance (for photographing) to 60in. At the proper point I would place between the two distances an enlarging lens so constructed that the normal image of the sun in the principal focus (then about half an inch) would be enlarged to two inches at the distance of ten inches from the principal focus, viz., at 70in. from the objective. The camera box and tube should be one tube, and the focalising rack and screw should be located at the objective end of the tube, thus simplifying the whole arrangement, and permitting the use of braces from end to end to prevent flexure; and on taking off the photographic corrector, and taking out the enlarging lens, the instrument will be all ready for vision. On consideration I do not think I would counsel a smaller telescope than the one I have named."

We are glad to see that Mr. Rutherfurd has consented to superintend the preparatory photographic constructions and experiments.

The last and longest, and perhaps most valuable, article in the pamphlet is by Prof. Newcomb, a member of the Commission, "On the Application of Photography to the Observations of the Transits of Venus." He speaks of the two methods which may be adopted for the purpose of observations. Of the first, which consists in fixing the moment at which the planet is in contact with the limb of the sun, he speaks in terms of strong depreciation, as almost entirely untrustworthy. The second method, and the one Prof. Newcomb recommends, consists in determining the relative position of the centre of the planet and the centre of the sun as often as possible during the transit. He then proceeds to examine some plans which have been suggested for the application of photography to this purpose, and to devise the combination among them which he thinks most likely to lead to the desired result. The objects to be attained he sums up as follows:—

1. To form an image of the sun with Venus on its disc of such a kind that from the outlines of the images the points on the photographic plates which correspond to the centre of the two discs, can be fixed with a high degree of precision. 2. The linear distance between these points being determined in millimetres, or other units of length, by means of a micrometer, we must have the means of deducing the angular distance to which this linear distance corresponds; or we must know the value of one millimetre in seconds of arc on each part of the photographic plate, and in each direction. 3. We must have a fixed line of reference on the plate, from which we can deduce the angle of position of the two centres relatively to the circle of right ascension passing through the sun's centre.

Prof. Newcomb then speaks of the necessity for the greatest possible accuracy in the measures; he thinks that, considering the accuracy with which the solar parallax can be found by other methods, we are justified in pronouncing it necessary that the errors at no one station rise to the $\frac{1}{10000}$ of the distance measured. In speaking of the size of image on plate, he assumes that the photographs must be taken by the "wet plate" process. As to size, he justly says that the test consists in the relative sharpness of the images; if it be found that a 2-in. image can be measured with twice the accuracy of a 4-in. one, it will answer an equally good purpose.

In reference to the modes of forming the solar image to be photographed, he thinks the only method that can be adopted is that devised by Prof. Winlock, which has been in successful operation for several years at the Harvard College Observatory, and which has been independently proposed by M. Faye, of the French Academy of Sciences. It consists in placing the telescope in a fixed horizontal position, while the sun's rays are thrown into it by a heliostat placed in front of the object-glass. After enumerating several of the decided advantages which he thinks it possesses, he proceeds to describe the appliances and methods by which the determinations are to be made in this system. What he says as to the heliostat we think very valuable, and shall endeavour to give a clear abstract of it.

If the reflecting surface of the heliostat be warmed by the rays of the sun, or if the two surfaces of the reflecting plates are unequally heated, then (1) the position of the effective optical centre of the angular value of the millimetre on the photographic plate, will be vitiated; (2) the image formed in the focus of the objective will be blurred. In considering effect (1), the problem is:—two rays from points in the heavens, at the angular distance γ, strike the reflector, whose radius of curvature is ρ, so as to meet after reflection near the optical centre of the objective; to find the difference γ' between these directions after leaving the reflector. γ' is the angle which will be measured on the plate, γ the angle we want. Call,

S, the distance between the points on which the rays strike the reflector.

A, the angle which the line joining the points makes with the plane normal to the axis of the telescope.

D, mean distance of the mirror from the objective.

$\delta\gamma = \gamma' - \gamma$, the error produced by the curvature of the mirror in the result of the angular measurement.

Then, $S = D$ sin. γ sec. A.

$$\delta\gamma = \frac{2S}{\rho} = \frac{2D \text{ sec. } A}{\rho} \text{ sin. } \gamma.$$

Sec. A may be supposed to be unity. Since it is desirable that the error of $\angle\gamma$ should not exceed $\frac{1}{40000}$ of its value, it is desirable that we have $\frac{\rho}{D} > 80{,}000$; and since it is necessary that the error should certainly be within a limit four times as great as this, we must have $\frac{\rho}{D} > 20{,}000$.

It will probably be found that at most of the stations the reflector can be placed within a foot of the objective. If so, the limit outside of which the radius of curvature of the reflecting surface will be unimportant, will be 80,000 feet, and that within which it will be inadmissible will be 20,000 feet.

As to the second effect, that on definition, if the curvature of the reflector cannot be kept within the limit of 80,000 feet radius, or if any small deviations without it cannot be determined with certainty, a serious and fatal objection will arise to the proposed plan. The practicability of attaining this desideratum is the first thing to be determined, and it can only be determined by trial and experiment. The most necessary precaution is that the reflector should be exposed to full sunlight only at the moment of taking the picture. When it is found necessary to use the reflected light for adjustment, the heat rays must, as far as possible, be cut off by a blue or green glass. The necessary time of full exposure of the mirror need not be more than half a second, or a second at most, for each picture.

The most perfect arrangement for moving the reflector would be that of the "siderostat" of Foucault, in which the mirror is moved round two axes in such a manner that the reflected rays remain parallel as the sun passes along its parallel of declination by its diurnal motion, the change due to refraction excepted. The adjustment of the reflector must be made so that the direction of the reflected ray shall vary from that of the telescope as little as possible during the transit. The motion of the mirror must be free from all vibrations, and every instrument must be carefully tested for this condition before being used. To avoid all serious danger of vibration, Prof. Newcomb proposes that no toothed wheels shall be allowed in the moving machinery, but that all motion shall be communicated by fine and well-oiled tangent screws. Whether the mirror should be of plain glass, silvered glass, or speculum metal, is a question to be settled by experiment.

Prof. Newcomb then proceeds to give some valuable suggestions as to the objective, the tube, arrangements at the focal points, the exposing of the plate, determination of the planet's position on the sun's disc, and the angle of position. These are an admirable *résumé* of and criticism on the best results that have been hitherto arrived at on these points. His concluding remarks are worth quoting:—"The determination of the solar parallax from measures of photographs of the sun taken during the transit of Venus is beset with this serious difficulty. That the required element appears only as a minute difference between two comparatively long arcs, much longer, in fact, than are often measured with a micrometer. In order that the solar parallax may thus be determined with a precision exceeding that attained by other methods, it is necessary that the arcs in question be measured with a precision considerably exceeding any ever attained in the astronomical measurement of an arc of similar length. The difficulties of the operations are greatly aggravated by the direction and motion of the body to be photographed, which require the apparatus to be mounted on moving axes, and demand either an instrument of unwieldy proportions, or the use of an enlarging lens. In Prof. Winlock's apparatus the diurnal motion is thrown entirely upon the revolving mirror, so that all the advantages of a fixed horizontal sun are obtained. The apparatus is all firmly mounted on stone piers, thus admitting of exact measurement of all its parts, and avoiding all danger of changing the adjustments by the photographic manipulations. It seems to be that the advantages are all greatly in its favour."

We hope that the Commission will very soon be able to publish an equally, if not more, interesting and valuable collection of papers, containing the results of their own independent inquiries and experiments. We only hope that the preliminary work will be as efficiently done in other countries as there is every promise of its being done in the United States.

THE "HASSLER" EXPEDITION

WE are again indebted to the *New York Tribune* for the following account of the final labours and total results of Prof. Agassiz's expedition:—

SAN FRANCISCO, CAL., Sept. 2.—The steamer *Hassler* reached Acapulco on Sunday evening, Aug. 4, and remained 70 hours. The fishermen of the place were very active, and our own scientific party were not behindhand in diligence, so that these 70 hours yielded the Professor as rich a harvest as he has gathered in almost any port. Acapulco is a lovely Sleepy Hollow; its quiet little bay completely enclosed by beautiful mountains; its environs adorned with a profusion of tall cocoa-nut palms; the promenade from the town to the fort, half a mile distant, shaded by magnificent old lime trees; the town itself clean, old-fashioned, quiet; only three or four vessels in the port. If it had not been for the heat, we should have voted it the loveliest imaginable retreat. Two of the vessels in port were English, and I had one or two pleasant interviews with their captains. As we were parting, I mentioned to one of them that I had long wished to visit England. His answer was pre-eminently English:—"He thought a visit to England would be useful to me; it might remove some prejudices and hard feelings." Now, as I am absolutely certain, and do positively know, that I had not betrayed to him in any way or manner the least shade of prejudice or hard feeling toward the mother country, I must explain his remark by supposing that he was himself conscious of hard feelings toward the United States; and therefore presumed that I felt them toward England. The confidence with which an Englishman applies his English foot-rule to measure the universe is a very marvellous thing; it is as if he thought that the laws and customs of his little island are universal laws of humanity, and he seems incapable of supposing it otherwise.

We left Acapulco August 7. The scenery as we went out of the bay, passing between the islands and the main land, and for several miles after emerging into the Pacific, was exquisitely beautiful. The high hills behind the town reminded me of paintings which I have seen of Hymettus seen from the hill of the Museum. We have hardly seen on the whole voyage anything more picturesque and beautiful. The evening closed with a magnificent sunset. South of the sun were long streamers of golden clouds, and just north of it was a patch of the bluest imaginable sky, broken by three or four projections of brilliant cloud. Our views toward the north were lovely beyond description; the sea nearer to us was the deepest blue, toward the shore becoming purple; then came a long golden beach; behind that deep green hills; behind these a line of purple hills; still farther back blue mountains, and then over all a series of clouds of varying shades. On the evening of the 9th, off Cape Corrientes, we had a heavy shower, a thing that six weeks in the rainy reason had rendered familiar to us. But the next morning we were in a different climate, cool, dry, and pleasant; and gliding on smooth seas, we reached the western edge of the Gulf of California on the evening of the 11th. By noon of the 12th we had a strong head-wind which seemed positively cold after the sweltering heats of Panama and Acapulco. At sunrise on the 13th we anchored in Magdalena Bay, where we remained thirty hours, seeing only the two great islands which form the outer defences of this magnificent harbour. We found here a small colony gathering orchilla, a lichen (*Roccella*) from which cudbear is made. The plant only grows in comparatively rainless regions, and grows very slowly, so that the gathering of a crop leaves the field barren for many years. The bushes on which this lichen grows are of but few species, and most of them of very odd appearance. The animals in the sea were very interesting, and our thirty hours yielded us a rich harvest.

Good weather and favourable winds brought us into the harbour of San Diego by noon on Sunday, August 18. We had not been here long before a telegram ordered the *Hassler* to return to the Mexican coast and sound for a rock reported to have been seen in a certain place. The *Hassler* obeyed, and was gone several days, searching for a rock which probably does not exist, the scientific party meanwhile remaining in San Diego. It was a delightful place for the naturalists and for us all. It was our own country, and we were at home; and among hospitable people who at once made us feel at home. A few Chinese (washers and ironers and fishers) seemed to be the only low people in the place, if we except a few Indians in tents in the adjoining fields. All the rest—I speak of the new town—seemed to be industrious, respectable Americans, Germans, or Spanish. The harbour is a long crescent. The protection is from a long range of hills running southward in a promontory to the west, and two flat islands on the south connected with each other and the continent on the east by a narrow strip of sea beach. On the north side of this crescent are numerous little villages, two of which, Old San Diego and New San Diego, are of considerable importance. In the new town two daily papers are published, and a steamer leaves five times a month for San Francisco. While we were there the town was intensely excited over the arrival of Col. Scott and other railroad magnates, to make arrangements for the commencement of work on the western division of the Texas and Pacific Road. The town has been built in faith that a railway communication with the Atlantic must at no distant day be opened with this the best harbour in the southern part of California. But hope deferred had begun to make the heart sick. Those who had not means of living had begun to consider the expediency of retreating to some place of greater activity. But the visit of Col. Scott, and the arrangement made by him with the citizens of the town, have put every one at San Diego into high spirits, and they look forward now, I think reasonably, to the rapid growth of their city.

The harbour is excellent. It needs some care to prevent the San Diego River from filling it with sand, to prevent the ocean from breaking the beach that connects the island, and thus obviate the present "scour" in the main entrance; and to prevent wharf and other "improvements" in the distant future from doing the same mischief. The situation of the town is fine, on a gentle slope, with a hard pan foundation for building. The climate is wonderfully equable, it is rather too dry, but windmills are cheap; the direction of the wind is so uniform that the windmill need only be set for west winds; and with a windmill to irrigate one can raise any crop. Many plants, as olives, figs, grapes, &c., only need irrigation for a time and then strike root deep enough to reach perennial moisture. Frosts come only at intervals of many years and are then exceedingly light. We ate tomatoes gathered from bushes that had yielded fruit freely every week in the year for three years past. The melons were of an excellence surpassing anything I have ever tasted. The city is well laid out, and the nucleus of citizens already there is of sterling quality. The Horton House, which is the principal hotel, is admirably kept in the neatest and most comfortable style, with gas, water, and other conveniences, and a good table. One can make oneself at home there as well as in any city of larger size. I met also many persons in private at whose houses I had evidence that some of the best fruits of English and German, French and Spanish civilisation are acclimated here. In zoology our naturalists found a rich field. Fifty-three different species of fish, and sixty or seventy species of other animals, were added to their collections, many of these species being of very rare and valuable kinds, and several probably new. Most of these were found in such abundance that the Professor could take just as many as he chose, as many, that is, as he thought he could make useful at home.

On August 28 we parted with real regret from our new-made but most cordial and hospitable friends at San Diego, and, being again greatly favoured by the weather, we made the Golden Gate on the 31st at sunrise, and dropped our anchor in the harbour of San Francisco at 9 o'clock. The expedition proper here ended, but Prof. Agassiz, with Dr. Steindachner, will remain to gather what they can in this harbour before returning. Their success during the whole voyage in collecting valuable specimens of fish and other animals has been truly wonderful; new and unknown species have apparently been everywhere awaiting their arrival to reveal themselves; rare and valuable fishes have come freely and in numbers to give themselves up, and the more ordinary species have come into their nets in superabundance, so that we have thrown back living into the sea very frequently more than half of what the seine brought up. The whole number of fish brought home from the voyage will probably exceed 30,000, and the other animals of all descriptions will probably swell the number of specimens brought home to over 100,000. It is, however, the quality and kinds that give value to their collection rather than the mere numbers; and the *Hassler* Expedition will have prominent place in the history of zoology, because of the number of new species discovered, as well as for the valuable collection of materials on which original anatomical investigations may hereafter be made. In the history of physics the exhibition will also be remembered, not for the deep-sea dredgings which circumstances beyond the control of the officers of the vessel prevented it from making, but for the valuable geological observations made for the first time in the south temperate zone by an observer thoroughly conversant with the action of glaciers and the glacial sheet north of the equator; the observer who first detected the marks, now apparent to every eye, which demonstrate the existence of glacial sheets before the birth of the present glaciers, even in their most extended form. During nine months the little company have received the courteous attention of the officers of the *Hassler*, and enjoyed the rare privileges which the Superintendent of the Coast Survey and Secretary of the Treasury had granted; nine months of continuous and varied enjoyment. The *Hassler* came round South America to survey the Pacific coast of the United States, but the long voyage has not been idle. It has been employed incidentally in a manner not less valuable than the work to which the vessel is specifically devoted.

ON THE FERTILISATION OF A FEW COMMON PAPILIONACEOUS FLOWERS

II.

VICIA SATIVA.—In the general structure and character of petals, stamens, and pistil, this flower agrees with Lathyrus; but there is a remarkable difference in the shape of the keel, and correlatively in the hairs or brush on the style.

In Lathyrus, as we have seen, the upper part of the elastic style is curved, so that the curvature corresponds with the curvature of the keel; the back or outside of the style presses against the inside of the keel, and is not furnished with hairs, there being no space for pollen on that side, whilst the inside of the style is covered with hairs set upwards, so as to sweep out the pollen which accumulates on this side.

In *Vicia sativa* the keel forms a less regular curve, whilst the style, instead of following the curvature of the keel, is set on at right angles to the ovary, and is straight and perpendicular throughout its whole length. There is, therefore, a large nook or corner outside the style, and between it and the keel, into which the pollen gets. Correlatively the style is not furnished with abundant hairs on the inside, as in Lathyrus; but there is a little tuft of stiff hairs on the outside, a little below the stigma, set on upwards so as exactly to brush out the pollen from the nook of the keel, when the keel is pressed down by an insect (see Fig. 9).

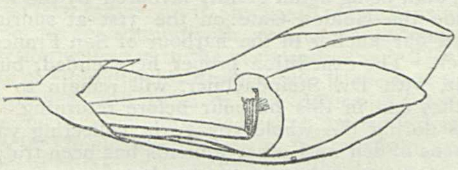


FIG. 9.—*Vicia sativa* (keel and pistil).

Vicia sepium is similar in construction to *V. sativa*. I have not observed whether there is nectar within the staminal tube of *V. sativa* or *V. sepium*, but feel assured that it is to be found there.

Vicia Faba. In the several positions of its buds and pods, Faba (broad bean) differs from Pisum and Lathyrus, and agrees with Phaseolus. The buds are upright; in the flower they are horizontal, and in the pod they are again upright; but the blossom, when open, is, as in all the other cases, horizontal, so as to afford a good lighting place for bees which seek the nectar in the interior of the staminal tube. This tube, the separate stamen, the shape of the keel of the style with its brush, are similar to those of *V. sativa*.

Robinia pseud-Acacia.—This plant bears its flowers in a pendent raceme; consequently, the position of the flower is reversed. The fifth sepal should be uppermost, and the vexillum lowest, with its back to the peduncle; and this is the position of the unopened buds. But as they approach maturity, *i.e.* as the blossom opens, the pedicel of each flower takes a half twist, so as to bring the flower into what we may call the normal position of Papilionaceæ, but with the vexillum uppermost and upright, or nearly so, and the wings and keel horizontal, the open side of the keel being uppermost. The keel is obtuse, and is free from the wings.

The filament of the tenth stamen is joined to the others in the middle, with apertures between it and the others at the base, and there is a cavity at the base of the staminal tube containing nectar. The stigma has a very small brush round it, and there are a few hairs on the inside of the style which seem to sweep out the pollen. The flowers are much frequented by bees.

Wistaria sinensis.—The pendent raceme of this plant displays, as regards the position of the buds and flowers, the same features as that of *Robinia pseud-Acacia*, which it also resembles in the free boat-shaped keel, the semi-separated tenth stamen, and the nectar-holding cavity of the staminal tube. It differs in having no hairs on the style, a difference possibly connected with the character of the pollen. But as the flower does not usually produce seed in this country, it seems unsafe to speculate on such a point.

Onobrychis sativa, or Sainfoin.—In the long raceme of this plant, the pedicels of the flower are nearly perpendicular in the bud, horizontal, as usual, in the flower, and again, after flowering, resume a position approaching the perpendicular. The wings are very small, and are not attached to the keel, and seem to play no part in fertilisation. On the other hand, the keel is large, boat-shaped, prominent,

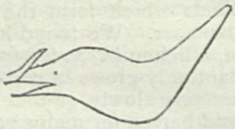


FIG. 10.—*Lotus corniculatus* (keel).

and being joined together to the apex, and having the petals folded over one another when not joined, affords a broad and easy alighting place for insects. The tenth stamen is separate at the base, and the staminal tube so formed that it may contain nectar. Whether it does so or not I have not observed. The filaments are stiff, and the pollen sufficiently dry and dusty to come out in abundance on pressure being applied to the folded top of the keel. The stigma comes out first, and often remains outside the keel, whilst the stamens, on pressure being removed, resume their position.

Trifolium repens (Dutch Clover).—These flowers, being in an umbel, afford a good foothold for bees, and do not require an alighting place on each flower so much as in the case of larger and separate blossoms. Nevertheless, they are upright in the bud, inclined in the flower, pendent and recurved after blossoming. No flowers are upright in full blossom, and consequently the centre or summit of the umbel becomes bare. The flowers thus tend to the usual position, even though in an umbel.

The claws of the wings and keel are united, and form a half tube, containing within them the staminal tube. The tenth stamen is perfectly free, and the staminal tube, as usual in such cases, contains nectar. Bees are fond of the flowers, and must, in entering the half tubes of the keel and wings, meet the stigma and carry away pollen.

FIG. 11.—*Lotus corniculatus* (dilated filament).

Trifolium pratense.—The position of the flowers in the umbel changes as in *T. repens*, though in a less marked manner.

The long claws of all the petals, including the vexillum, are united so as to form a complete tube, at the bottom of which is much nectar. The limb of the keel is open at the top, but the aperture is small, so that an insect entering cannot fail to touch both stigma and anthers.

The filaments of the nine stamens cohere to one another, and to the tube of the corolla from the point of union of the petals, so that there is no separate staminal tube. The tenth stamen is entirely separate for its whole length. Looking to the course of the apparent veins of the petals and stamens on the tube, it seems as if the vexillum really formed the tube, and as if the nine united filaments of the stamens by themselves would leave a large aperture, and were widely separated from the tenth stamen. If so, it is curious to see the nectar-holding cavity so often formed by the stamens here formed by the vexillum. The entire freedom and wide separation in the tenth stamen, in a flower displaying such a tendency to cohesion, is also curious. Possibly this is necessary in order to preserve a sufficient aperture to give access to the nectary.

Lotus corniculatus.—The flowers of this plant again, though in umbels, when open assume the normal position with the vexillum uppermost.

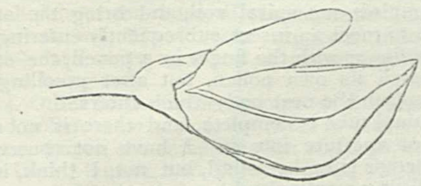


FIG. 12.—Lupin (flower with one wing cut off).

The wings are free from the keel. The keel is long, pointed, and united for some distance above as well as below, with an aperture at the apex (see Fig. 10). The tenth stamen is free, and is separate from the others at the base; the staminal tube is stiff and enlarged at the base into a cavity, which contains nectar. The pollen is moist and abundant. The style is capitate and stiff, but without hairs or brush. How then can the moist pollen be forced out of the narrow mouth of the long pointed keel so as to meet an entering insect? In a very curious way. Five

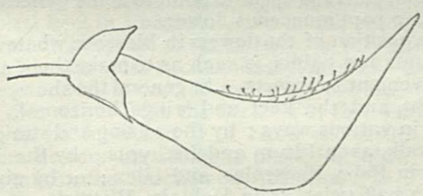


FIG. 13.—Lupin (keel).

of the stamens, viz. those of the inner whorl, are shorter than the others, and their filaments are dilated at the top. These filaments are stiff, and, I believe, continue to grow after the five anthers of the other whorl have shed their pollen. The dilatation of the filament is wedge or club-shaped, the broad end of the wedge being uppermost (see Fig. 11). Consequently, on any pressure being applied to the keel, the broad ends of these wedges, supported by their stiff filaments, collect the pollen, and push it before them to and out of the mouth of the keel, where it is seen to adhere to

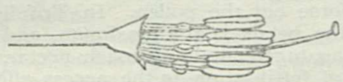


FIG. 14.—Lupin (Stamens in bud).

the body of the insect which is passing down the keel. It is to be observed that the shape of the dilated filament is such that, whilst pollen might work past it from below upwards, the broad flat upper end of the filament meeting the narrowing tube of the keel can scarcely allow it to pass downwards.

Garden Lupin (common tall blue and white).—In the long raceme of this plant the pedicels are nearly perpendicular in the bud, become horizontal whilst the blossom is open, and rise so as to approach the perpendicular again afterwards. The wings are attached to each other below, are blunt, and are folded over at top so as to afford an excellent resting place. They are not attached to the keel, and move downwards more easily than it does. The keel is very long, very pointed, and the upper edges are slightly connected with an opening at the apex so as to form an approach to a tube. The apex just appears between the wings. The upper edges of the keel are furnished with a few hairs (see Figs. 12 and 13).

The filaments of the stamens are entirely joined together so as to form a close fitting tube round the ovary. There is no cavity within the tube for nectar, no apertures into it at the base, and it is too long and too close fitting for an insect to thrust its proboscis down.

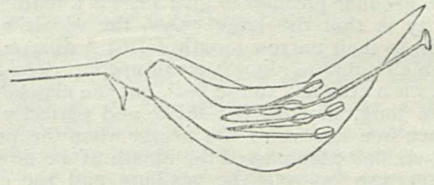


FIG. 15.—Lupin (keel with one side cut off).

There is a cavity at the back and base of the vexillum in which I have not been able to find nectar. But the bees, which constantly visit these flowers, certainly go to this cavity for what they want, and not to the staminal tube. Five of the stamens compose, I believe, what must be the outer whorl, are longer in their filaments than the other five, and have longer anthers (see Fig. 14). These are mature, and before the flower opens have shed their pollen, which remains in a moist mass towards the mouth of the pointed keel. Their filaments then wither and contract. The other whorl of stamens are shorter, and the anthers much

FIG. 16.—Lupin (style and stigma).

smaller, but they are later than the first whorl, and their filaments grow and remain stiff after the filaments of the first whorl have withered. They consequently, on pressure being applied to the keel, thrust the mass of pollen upwards to its mouth. The style is long, and a ring of hairs surround the stigma, of which the upper and inner are the longest, and all of which are set upwards, so that on pressure being applied to the keel the hairs sweep out the mass of moist pollen which the stamens have thrust to the mouth (see Figs. 15 and 16). It is quite pretty to watch the little stream of bright orange pollen

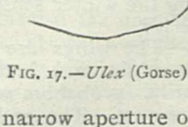


FIG. 17.—*Ulex* (Gorse).

emerging from the narrow aperture of the blue keel, and between the bright blue wings.

The shorter yellow and blue garden lupins and *Lupinus arboreus* are similarly constructed. In the latter flower the folding over of the wings at the top, and the cavity at the base of vexillum, are strongly marked.

What is the use of the hairs on the edges of the keel?

Ononis arvensis.—The vexillum in the opened flower is perpendicular or a little bent back; and the wings, which are small, are also perpendicular, so that an insect may light either on the vexillum or on the wings, and has to thrust itself between the vexillum and the wings.

The keel is long and pointed as in Lotus and Lupin: and the stamens push out the pollen as in those flowers.

The stamens are quite monadelphous, the staminal tube is close fitting, and there is no nectar and no space for nectar within it. The humble-bee certainly does not put his proboscis down the tube, but between the tube and the vexillum.

Anthyllis Vulneraria.—This flower being in an umbel needs no peculiar position to give insects a foothold. Its peculiarity is that the large calyx, the sepals of which cohere up to their narrow mouth, forms a dilated tube or vessel which contains abundance of nectar. The limbs of the wings are attached to the keel, but the claws of all the petals are long, narrow, threadlike and perfectly free, so as to leave free access to the nectar when the proboscis of an insect has once passed the mouth of the flower.

The aperture between the vexillum and the coherent wing and keel is however very narrow, so that an insect in passing it cannot fail to push the keel outwards and bring out the stiff style and stamens. The filaments are entirely joined together, and form a long close fitting tube in which there is space neither for nectar nor for the proboscis of an insect.

Ulex nanus (Autumn Gorse.)—This flower is upright in the bud, assumes the usual horizontal position when in blossom, and reverts to the upright position in the pod. The bud is protected by a stout, large and hairy calyx, and the pod is stout and hairy.

The wings are perfectly free from the keel, and the rounded lobes of the keel are separate from one another at the extremity and for a considerable part of the lower side, so as to make the flower comparatively open. The stamens and pistil are stiff, and come out on the keel being pressed down; and the pollen, which is dusty, comes out in a cloud.

The staminal tube is perfectly closed and close fitting. There is no cavity in it for nectar, and no aperture at the base. There are traces of nectar on the veins and in the hollows of the vexillum, especially on the midrib and in the hollow towards the base. The bees are fond of it. They settle on the keel and thrust their heads between it and the vexillum, pushing the latter upwards. In struggling to do this their legs are in violent motion on the top of the keel, pressing it down. In doing this they invariably open it, make the anthers project, and dust their own body with pollen ready to meet the stigma of the next flower (see Fig. 17).

The contrast between the free wings, the obtuse and semi-attached lobes of the keel, the stiff filaments, the hairless style, and the dusty pollen of Ulex, and the adherent wings, closed keel, moist pollen, and brush-clad style of Pisum, Vicia, Lathyrus, &c., and the correlation between these differences, having regard to the ultimate object in both cases, viz. the conveyance of pollen by an insect, are very striking.

Ulex Europæus is similar to *Ulex nanus*, and I have seen bees upon it in April. But are there enough of these insects abroad during the winter season, when this flower blossoms, to fertilise it?

Genista Anglica.—The wings are separate from the style, the keel is straight and horizontal, but is reflexed after maturity, probably when it has once been visited by an insect. The anthers have stiff filaments and dusty pollen, all of which is shed when the flower is once opened.

The style is stiff, and coils back on the opening of the keel, whilst the stigma is oblique. When so curved back the stigma would touch an entering insect. I have not ascertained where the nectar is in this flower, but probably not in the closed and close-fitting staminal tube.

Sarothamnus (Broom.)—The keel is perfectly free from the wings, is obtuse and closed when the flower first opens. In this stage the style is bent against the keel in such a way that its stigma (which is at the extremity) is turned away from an entering insect. At a touch the keel opens and falls down by a sort of hinge, and does not recover its position. The stiff stamens shed their dusty pollen, as in Ulex and Genista. The elastic style at the same time coils itself inwards towards the vexillum. In a few moments it has curved back so far as to complete one spiral coil, and bring the stigma round so as to meet an insect subsequently entering. In opening the flower with the finger or a pencil, the stigma does not catch its own pollen, but after recoiling can hardly fail to rub the next body which enters.

The staminal tube is complete, and there is no space for nectar or aperture into it. I have not ascertained where the nectar is to be found, but not, I think, in the thin, close-fitting staminal tube.

Cytisus (*qu. nigricans?*)—common in London greenhouses.—The raceme is terminal; the peduncle is nearly horizontal. The pedicels are set on all round the peduncle, but in blossoming are so bent upwards as to make the vexillum of each flower nearly upright, and the keel and wings nearly horizontal, *i.e.*, so as to bring the flowers into the normal position.

The separation of the petals, the reflexion of the keel, the closed staminal tube, and the dusty pollen, are the same as in Sarothamnus and Genista. There is no nectar, and no place for any in the staminal tube.

The above details seem to point to some generalisations concerning papilionaceous flowers.

1. The position of the flowers in blossom, whatever their other wants and habits, is such as to make them attractive and convenient to insects. In general the showy vexillum is upright, and the keel and wings horizontal. This is effected in various ways: by the raising and straightening of the stalk, as in Pisum and Lathyrus; by the lowering of it, as in Faba, Phaseolus, and Ulex; or by giving the pedicel a half twist, as in Robinia, Wistaria, and Laburnum.

2. The cohesion of the petals (which in this single tribe is so various) is in each flower correlated to the position of the nectary, the structure of the fertilising apparatus, and the nature of the pollen. Thus in Ulex, Genista, and Sarothamnus, the cohesion of the petals is at a minimum, the wings do not adhere to the keel, and the keel itself is comparatively open. Correlatively the filaments are stiff and the pollen dusty, and the insect gets freely dusted with it, without aid from any union of the petals. In Pisum, Lathyrus, Vicia, Phaseolus, and others, the wings not only serve as a landing place for insects, but, being united to the keel, serve to pull it down and force out the pollen. In Trifolium, the coherence of the petals is at a maximum, and produces a complete long tube containing much nectar, and having the organs of fertilisation in the access afforded by its narrow mouth. In Anthyllis the claws of the petals are so thin and so free from each other as to afford no receptacle for nectar, whilst the staminal tube is closed and tight fitting, but the want of a nectary is made up by the cohesion and form of the calyx. The various degrees of cohesion between the petals of the keel—from the comparatively free keel of Genisteæ, through the prolonged acute keels of Lupin and Lotus, and the oblique keel of Lathyrus, to the spiral tube of Phaseolus—and the adaptation of each of these forms to its own stamens and pistil, is no less remarkable.

3. The degree to which the cohesion of the stamens is carried (so remarkable a feature in this tribe) appears to depend on the necessity for access to nectar. In

those flowers in which the stamens are monadelphous, viz., Ulex, Sarothamnus, Genista, Cytisus, Ononis, Lupin, there is no symptom of nectar within the staminal tube, no space for it, and no access to the interior. In some, at any rate, of these, viz., Ulex, Ononis, and Lupin, the bees certainly resort to other parts of the flower. On the other hand, where the tenth stamen is entirely free, or where it is separated at the base, so as to give an insect access to the interior of staminal tube, as in all the other flowers I have described, there is a cavity for nectar within the staminal tube, and there is nectar within this cavity.* As regards the double aperture, viz., one on each side of the base of the separate stamen, which so often occurs, Mr. Darwin suggests that, one aperture being necessary, the law of symmetry will account for there being two.

4. Other points in the structure of the filaments, anthers, and pollen seem also to be more or less related to and to depend upon the same function of fertilisation by insects. In Ulex, Genista, and Sarothamnus, where the flower is open, and in Lupin and Lotus, where the agency of the filaments is required to drive the pollen out of the keel, the filaments are stiff. In Phaseolus, where the style performs this function, they are limp. In Lotus and Lupin, the peculiar form and growth of the second whorl of stamens, and their adaptation to this function, is most remarkable. In Pisum, Lathyrus, Vicia, Phaseolus, and Lupin, where the pollen is moist, there is an apparatus for sweeping it out. In Ulex, Genista, and Sarothamnus, where it is dusty, the flower simply opens and it comes out of itself.

5. The structure of the style and stigma is in every case adapted so as to bring the latter in contact with an entering insect. In some cases, *e.g.*, in its emergence from the spiral keel in Phaseolus, and in the recoil of the style in Sarothamnus, this is effected by a very elaborate process. But the most peculiar function of the style in many of these flowers is that of sweeping out the moist pollen of its own flower from the keel. For this purpose it appears to be furnished with hairs or bristles, placed in different flowers on different parts, but always so placed as to perform the function in question. In Pisum, and, generally, in Lathyrus, the brush is on the inside of the style; in *Lathyrus grandiflorus* on both sides; in Phaseolus all round the style, but more thickly on the side next the entering insect than on the other; in Vicia on the outside of the style; in Lupin at the very extremity; but with all these differences it is always so placed as to find the pollen and sweep it out of the variously constructed keels. In this respect these flowers remind one of the brush-clad styles of the Campanulaceæ.

6. It is scarcely necessary to repeat that the nectar is found in various parts of the flower—within the staminal tube, in the vexillum, and in the calyx. But in all cases the correlation of the parts is such that an insect seeking the nectar must touch the stigma and carry away pollen.

These generalisations, if even partially correct, seem to me to be of considerable interest, not simply as illustrations of the mode in which insects fertilise flowers by carrying pollen from one to the other, but because by connecting the facts of morphological structure with living physiological functions, they give meaning and interest to the former, and possibly indicate the direction in which the true cause of that structure is to be sought.

It is but right to add that there is one genus, *Coronilla*, which, so far as I have been able to observe it, forms an exception to the above generalisation; but I have not been able to procure sufficient flowers to enable me to state any positive conclusion with respect to this genus; and I only mention it in order to call the attention of other observers to it.

T. H. FARRER

* I have not actually looked for and found nectar in *Onobrychis sativa* and *Lathyrus macrorhizus*, but have no doubt that it is there. I have found it in all the rest.

NOTES

DURING the absence of Prof. Tyndall in America, the opportunity is being taken to rebuild the laboratories of the Royal Institution on a considerably enlarged scale.

IT will be seen from our University intelligence that Mr. E. Ray Lankester, Scholar of Exeter College, Oxford, has been appointed Deputy to the Linacre Professor of Anatomy and Physiology at the University.

THE open Scholarship in Natural Science at St. Mary's Hospital Medical School has been awarded to Mr. Alfred Tilley, and the Exhibition to Mr. W. H. Weddell. Both these gentlemen are students of the London University.

THERE are now no fewer than five separate organisations at Cambridge for the improvement of female education—all of them thriving. 1. The examination of women, senior and junior girls, and of schools managed by a syndicate, of which the Rev. G. F. Browne, M.A., St. Catherine College, is the secretary. 2. A system of lectures for women, associated with four exhibitions, and a fund for assisting governesses, managed by a mixed committee of ladies and gentlemen, of which H. Sidgwick, M.A., Trinity College, and Mrs. Bateson, St. John's College Lodge, are the treasurers. 3. A series of classes by correspondence arranged by Mrs. Peile. 4. A lending library for students, managed by Miss J. Kennedy. 5. A college for women, called Merton Hall, of which Miss A. J. Clough is the principal. We understand that this last establishment is rapidly filling. The lectures commence this week.

THE Vestry of St. George's, Hanover Square, advertised some time ago for a medical officer of health and analyst for the parish, and a considerable number of candidates have, we understand, come forward. It has been suggested in various quarters that the Vestry would do well to appoint two officers instead of one; and on this point minds are divided. While some are in favour of a double appointment (with, we suppose, double pay?) others say that the Vestry are not likely to do this, and that it is undesirable that they should, seeing that their real want is an accomplished scientific sanitarian, who will, if necessary, appoint an assistant to do the routine chemical work, just as he has an inspector to do the routine sanitary work, but who will supervise everything and be responsible for everything. It is further urged that it is absurd to suppose that chemical knowledge is not continually required from a medical officer of health, quite apart from the provisions of the Act for the Adulteration of Food and Drugs, and equally absurd to suppose that a medical man without previous special sanitary experience is at all fitted to become at once medical officer of health to so important a parish as that of St. George's, Hanover Square. We confess we have a leaning to the latter view.

AT the last meeting of the Council of the Pharmaceutical Society, it was resolved unanimously that the resolution passed in 1862, prohibiting ladies from attending the lectures, be rescinded, and that ladies be admitted as students to the lecture classes of the Society. At present but one lady has taken advantage of the privilege offered; but as soon as the resolution becomes more widely known it is probable that the liberality of the Society will be recognised by ladies, who will avail themselves of this excellent opportunity of studying practical chemistry and botany. The lectures on chemistry are by Prof. Redwood; those on botany by Prof. Bentley, commencing early in October. The chemical lectures are continued three days a week until the end of July; the botanical lectures, lasting for the same period, being delivered on two days in the week. During the summer months they are delivered in the Botanical Gardens, Regent's Park.

A RUSSIAN lady, who desires to be anonymous, but is rumoured to be "still very young, and a native of Siberia," has offered 50,000 roubles for a medical course for ladies, to be given at the Imperial College of Physicians. Classes are to be formed ostensibly for midwifery, but this will not exclude the higher studies of medicine. The course is to be one of four years' duration. The threat from Zurich no longer to admit the "unprepared Russians" proves thereby a wind that blows somebody some good. "I hear," says the correspondent of the *School Board Chronicle*, "that Madame Souslof's practice at St. Petersburg is actually undermining that lady's health."

THE nationalities represented at the International Commission on the Metric System recently sitting at Paris, are the following:—Great Britain, Germany, Austria and Hungary, Bavaria, Belgium, Denmark, Spain, France, Greece, Italy, Holland, Portugal, Russia, the Papal See, Sweden, Norway, Switzerland, Turkey, Wurtemburg, United States, Chili, Argentine Republic, Colombia, Equador, Hayti, Nicaragua, Peru, San Salvador, Uruguay, Venezuela. We believe, though it is a fact not generally known that Her Majesty's enlightened Government at first refused to allow England to be represented!

THE foundation stone of the New Watt Institution and School of Arts, Edinburgh, was laid on Wednesday, 9th inst., in Chambers Street, the spacious new street which runs on the north side of the College, and in front of the Industrial Museum.

THE vestry of Lambeth have appointed Mr. James Muter, F.C.S., analyst to the borough.

DR. J. E. EDDISON will deliver a course of eight lectures on "The Physiology of Circulation and Respiration," in connection with the Leeds Philosophical and Literary Society. The lectures will be strictly elementary, and as much practical illustration as possible will be introduced. The following single lectures will also be delivered during the ensuing season:—"Hill and Valley Sculpture," by Prof. Archibald Geikie, F.R.S., November 5 and 7; "The Meteorology of the Sun in connection with that of the Earth," by Prof. Balfour Stewart, F.R.S., December 3; "Radiant Light and Heat," by Prof. Balfour Stewart, December 13; "The Sense of Hearing," by Michael Foster, M.D., F.R.S., January 21, 1873; "The Primitive Social Condition of Man," by E. B. Tylor, F.R.S., February 4; "The Exploration of Moab," by the Rev. Canon Tristram, F.R.S., March 4; "On some new Phenomena associated with Magnetism," by W. F. Barrett, March 18.

THE following is the syllabus of the twenty-third session of the Manchester Scientific Students' Association:—The Physiography of Europe during the Pleistocene Age, by W. Boyd Dawkins, F.R.S., October 14. On the Glandular Hairs of the Fraxinella, Nettle, and Malpighia, by Charles Bailey, October 21. On Comparative Anatomy, by Herbert W. Oakley, October 28. On the History of a Mountain, by John Plant, November 4. On Meteors and Meteorites, by Rev. Joseph Freestone, November 18. On Horology, by Thomas Armstrong, December 2. And the following syllabus of papers is announced to be read at the Microscopical Club:—Glandular Vegetable Hairs, first paper, by Charles Bailey, October 3. On some Improvements in Oxy-hydrogen Illumination as applied to Microscopic Objects, by John Barrow, October 24. The Tetraspores of the Algæ, by John Hardy, November 14. The Polyparies of the British species of Hydrozoa, by Thomas S. Peace, November 28. The Micro-Spectroscope, by John Angell, December 12.

DURING the latter part of September, we learn from the *Times of India*, Bombay was visited by terribly destructive rains, causing not only serious injury to property, but great loss of life. Among the many instances of destruction on September 19 was that which occurred at the Library of the Asiatic Society—the largest collection of books, perhaps in India. The library is located in a series of rooms in the northern wing of the Town Hall, and before the commencement of the monsoon the roof had, as usual, been inspected, and, as it was supposed, made thoroughly water-proof. Whether owing to bad repairs, or to the excessive force of the downpour, the water found its way into one of the rooms—the room in which the librarian has his office—and completely saturated and more or less destroyed about three thousand volumes, chiefly works on jurisprudence. The expensive illustrated books, which are kept in the same room, fortunately escaped the general drenching. The injured volumes were spread out in the Town Hall to dry, but it is feared that the larger number of them are totally destroyed.

AURORÆ BOREALES were visible on the 3rd of August at Stettin and Cracow, on the 4th at Emden, on the 8th in North America, on the 9th at Emden and Thurso, on the 15th at various localities in England and Stettin. On the 7th of August a smart shock of earthquake was felt at Innsbrück, which was followed by three more on the 8th of the same month.

ON the 9th and 10th of September a severe hurricane passed over the islands of Guadaloupe, Martinique, Dominica, St. Kitts, Barbadoes, &c. Sixteen vessels, including the steamer *Isleman*, was wrecked at Martinique, and several lives lost. Every vessel in the port of Dominica was struck to pieces, and there also many lives were lost. Several ships were driven on shore at St. Kitts. The gale lasted all day on Tuesday, the 19th instant, the barometer commencing to fall from ten o'clock on the previous morning.

THE following is from the *Athenæum*:—A singular controversy has occurred at Constantinople. The Government have determined that instruction in the Imperial School of Medicine shall be given in Turkish, and have removed all the professors who cannot speak the national language. Of course this has occasioned an outcry on the part of the friends of those French-speaking professors who have spent many years in the country and have not chosen to acquire its language. The Turks say they started their school as a national school, and not as a foreign one; that the pupils receive inadequate instruction from its being conveyed in a foreign language; and that they have not been supplied, as they expected, with manuals in Turkish. The authorities have, therefore, determined to run the risk of the change, and attempt to get for this school, as for others, books and teaching in the vernacular. They maintain that, as medicine has for ages been taught in Arabic, it can be taught inTurkish.

THE *Moniteur Scientifique* informs us that at Proskau, in Upper Prussian Silesia, near the Prussian-Polish frontier, an agricultural college on a large scale has been established by the State, in which everything relating to agriculture, horticulture, arboriculture, and the rearing of cattle, horses, bees, and poultry is practically taught. In addition to several smaller lecture-rooms, there are two large amphitheatres, which will accommodate 200 students each; three separate chemical laboratories; a large distillery; beetroot sugar works; model brewery; museum for mineral and botanical collections; collection of agricultural implements; library containing 6,000 volumes; four farms. 5,000 hectares of forest land, and 4,000 hectares (= 2·47 acres to the hectare) of arable meadow land are attached to this institution, in which instruction is given by a staff of twenty-four professors. Proskau has 1,900 inhabitants, of whom 1,500 are Poles.

THE *Times of India* of August the 16th states that an agricultural society, to be called the "Bombay Presidency Agricultural Society," composed of influential gentlemen, has been organised in Bombay. The object of the society is to diffuse agricultural knowledge amongst the people in the Bombay presidency, by establishing a journal and issuing separate tracts on agriculture in Marathi and Guzerati, and, if possible, by founding schools for this special purpose. The journal and tracts will supply a want that has been felt for some time past, and the new society is one that ought to succeed, and, if properly managed, will be sure to be of immense service in the Bombay Presidency.

WE learn from the *Garden* that the directors of the Alexandra Park Company have requested Mr. M'Kenzie to prepare a scheme for establishing a school of horticulture, for which purpose about twenty acres of the grounds attached to the building will be set apart. As we have no school of horticulture in this great gardening country, we hope something more may come of this than of its short-lived and feeble forerunners.

THE Portuguese *Jornal de Horticultura Pratica* announces a forthcoming "Flora" of that country, by Señor Barao de Castello de Piava, who was formerly Professor of Botany in the Academia Polythenica. Great things are expected from the new work, in which the subject will be brought up to the level of the knowledge of the present day, including all the discoveries which have been made since the time of Brotero, whose once celebrated "Flora Lusitanica" is now seldom to be met with for sale.

A NEW *Révue des Sciences Naturelles* has recently been started at Montpellier under the management of MM. Dubreuil and Kecker, to be published every three months.

WE learn that the publication of the *American Journal of Conchology* has closed with the completion of its seventh volume. This quarterly, edited by Mr. George W. Tryon, has appeared under the auspices of the Academy of Natural Sciences in Philadelphia, and has included, from time to time, a great many very important conchological monographs, chiefly presented to the Philadelphia Academy, many of them accompanied by coloured plates. Hereafter, such communications will be published in the Journal of the Proceedings of the Academy itself.

THE Second part of the *Quarterly German Magazine*, just received, contains translations (still into very indifferent English) of only two articles: Dr. J. Rosenthal on Electric Phenomena, and Prof. de Bary on Mildew and Fermentation.

Les Mondes has a long description, with illustrations, of the new "Horloges electriques" of M. C. F. Milde, the principal of which is a commutator for distributing the hours in all directions. It consists of an electro-magnet proportioned to the requirements, whose armature, at the moment of attraction, acts upon the arm of a lever, which governs a sector, whose centre of rotation is upon a pillar.

AN apparatus has been recently devised in Germany for obtaining specimens of water at any desired depth of the ocean. A strong, heavy vessel, entirely closed and empty, has a valve through which water may be admitted, but which is only put in motion by means of powerful electro-magnets connected therewith. These magnets are also connected with a wire which accompanies the rope, by means of which the apparatus is lowered from the ship. When the empty vessel, which is in fact a plummet, has reached the required depth, an electric current is sent from the battery on shipboard to the coils below; the magnetism thus generated opens the valves, and the vessel is filled and ready to be drawn up.

ACCORDING to the correspondence of the *New York Herald*, an ingenious plan has been adopted by Prof. Agassiz's expedition for determining how far the submarine regions are pervious to light. A plate prepared for photographic purposes is inclosed in a case so contrived as to be covered by a revolving lid in the space of forty minutes. The apparatus is sunk to the required depth, and at the expiration of the period stated is drawn up and developed in the ordinary way. It is said that evidence has thus been obtained of the operation of the actinic rays at much greater depths than hitherto supposed possible.

THE BIRTH OF CHEMISTRY

II.

Thales of Miletus—Later beliefs in his doctrine—Anaximenes—Empedokles—Herakleitos—Anaxagoras—Demokritos—The Atomic Theory—Aristotle—The Ethereal Medium—Transmutation of the Elements—The Four-element Theory—Mode of interpreting it—Cause of the absence of Natural Science among the Ancients.

THE elements of the Greek philosophers were, as we shall presently show, rather *principles* than elements in the sense in which we speak of the sixty-five elements now known to chemistry. There was a marked tendency in the earliest period of Greek philosophy to make one element or principle fundamental, and to evolve the other elements and the world from it. Thales, of Miletus, who lived in the sixth century, B.C., and who was called "the first of natural philosophers" by Tertullian, and the "first who inquired after natural causes" by Lactantius, affirmed that water was the first principle of things, perhaps, according to some writers, because Homer had made Okeanos the source of the gods. At least we are reminded of the boundless watery chaos of older cosmogonies. This doctrine of Thales was not without its supporters during the Middle Ages, and, indeed, the convertibility of water into earth and air was not absolutely disproved until about a century ago. One of the ablest supporters of the dogma was Van Helmont (b. 1577, d. 1644), who affirmed that all metals, and even rocks, may be resolved into water; animal substances are produced from it, because fish live upon it; and vegetable substances may be also produced from it. This last assertion he endeavoured to prove by what would appear to be a very conclusive experiment in those days, when neither the composition of the air nor of water was known. He took a willow which weighed five pounds, and planted it in two hundred pounds of earth, which he had previously carefully dried in an oven. The willow was frequently watered, and at the end of five years he pulled it up and found that its weight amounted to one hundred and sixty-nine pounds and three ounces. The earth was again dried, and was found to have lost only two ounces. Thus it appeared that 164lb. of wood, bark, roots, leaves, &c., had been produced from water alone. Hence he inferred that all vegetables are produced from water alone; not knowing, as was afterwards proved by Priestley, that a constituent of the atmosphere called carbonic acid had furnished the solid part of the tree, although, indeed, there was much water with it. Boerhaave devotes a page of his big book to a discussion of "whether water be convertible into earth." He concludes that the small earthy deposit observed when rain-water is distilled, arises from the particles of dust which had settled on the water before its introduction into the distilling vessel. Mr. Boyle had previously affirmed that "a very ingenious person, who had tried various experiments on rain-water, put him beyond all doubt about this transmutation, for he solemnly affirmed, on experience, that rain-water, even after distillation in very clean glasses, near two hundred times, afforded him this white earth." Finally, Lavoisier, in 1770, communicated to the *Académie des Sciences* an elaborate paper, "On the nature of water, and the experiments by which it has been attempted to prove the possibility of changing it into earth." In this he conclusively proved that water cannot be changed into earth, although it be distilled backwards and forwards for many successive days. Here then we find the old Thalesian theory at last disproved, but not before it had endured for twenty-four centuries; and this is by no means a solitary example of the permanence of old ideas. We shall become acquainted with yet older theories, which are still admitted, and which seem to be essential to physical philosophy.

On the other hand, Anaximenes regarded air as the primal element, Herakleitos fire, Pherekides earth, and some philosophers grouped two elements together. Anaximenes held that clouds were caused by the condensation of air, rain by the condensation of clouds; he appears to have clearly connected condensation with cold, rarefaction with heat. Archelaus affirmed that air when rarefied becomes fire, when condensed, water. It was very generally believed during the Middle Ages that water when boiled was converted into air. Empedokles introduced the idea of four distinct elements—earth, air, fire, and water, not capable of passing one into the other, but forming all things by their intermixture. These elements are acted upon by two principles, a uniting force of amity, a separating force of discord, corresponding somewhat to our attraction and repulsion. He endeavoured to prove the four-element theory by the following crude experiment: wood is burnt upon a hearth, fire seems to be evolved from it, the smoke is air, moisture is deposited on the hearthstone, while the ashes are earth, hence wood is made up of earth, air, fire, and water. Empedokles was one of the first to materialise the Homeric gods; he applied his four-element theory even to them, declaring that Zeus was the element of fire, Here the element of air, Nestis the element of water, and Aidoneus the element of earth. Herakleitos (about 460 B.C.) made fire the primal element, and assumed that it condensed itself into the material elements, and that air, water, and earth were respectively formed as the fire became more condensed. He asserted, moreover, that all things are in perpetual motion and change, the moving force being fire; "fire is to him," says Schwegler, "even in individual things, the principle of movement, of physical as of spiritual vitality; the soul itself is a fiery vapour." We find in the fire of Herakleitos to some extent the attributes of what we now call a physical force; thus it is precedent to matter, and is the motive power of the universe, it influences and changes matter, it is perpetually undergoing transformation, but ultimately returns to its own form. Prof. Max Müller speaks of Herakleitos as "one of the boldest thinkers of ancient Greece." We can well understand why fire should, at a very early date, be regarded as chief of the elements, and the motive power of the universe; it had long been worshipped as a symbol of the deity by the Chaldæans; a worship which possibly originated with the Scyths; for Zoroaster, who introduced fire-worship among the Medo-Persic races, is supposed to have been a Scythian. Again, Agni, the god of light and fire, was placed first in the Hindu Trinity.

Anaxagoras of Klazomene (B.C. 500) asserted that originally all things existed in infinite disorder; before the creation there was a chaos of mingled particles of matter, which were arranged in order by a designing intelligence or mover of matter (νοῦς). The primitive constituents of things are not definite elements, like those of Empedokles, but are *homœomeries* (ὁμοιομέρειαι) that is *like parts*, small particles of matter like the masses they produce when they aggregate. Thus a mass of iron is produced by the aggregation of an infinite number of iron-homœomeries brought out of the chaos by the νοῦς, which latter possesses vortical motion which enables it to separate like parts and bring them together, somewhat on the principle of gold-washing. If a dish containing substances of different relative weight, such as cork, sand, and lead shot, intimately mixed together, be caused to rotate, like particles will come together, the lead in one place the sand in another, and this experiment will help us to realise to some extent the meaning of Anaxagoras when he assumes that the vortical motion of the νοῦς caused homœomeries to aggregate and form the world. Leukippos taught that the world is produced by the falling together of small indivisible particles or *atoms* (from α and τεμνω), which are the principles of things, and which possess rapid circular motion. Demokritos (460 B.C.) extended the atomic theory of Leukippos; he contended that the principles of things are atoms and a vacuum. The atoms are invisible by reason of their smallness, indivisible by reason of their solidity, impenetrable and unalterable. They have no other qualities, neither heat, nor cold, nor colour. Atoms are infinite in number, the vacuum is infinite in magnitude. Atoms differ from each other in size, shape, and weight. They are actuated by necessity or fate (ἀνάχκη), and possess an oblique motion in the vacuum, which causes atoms of like shape to collide and group themselves together, by which means all things are formed. The vacuum is necessary, otherwise motion of the atoms would be impossible, because there would be no place to receive them. Long before the time of Demokritos an atomic theory had been proposed in India by Kanáda, the founder of the Nyaya system of philosophy, of which this theory forms the distinguishing feature. The theory of Leukippos is attributed by Possidonius to Moschus, a Phœnician. During the Middle Ages many writers made the atomic theory a prominent part of their system. Descartes adopted it in a somewhat modified form, and associated with his particles the vortical motion possessed by the homœomeries of Anaxagoras. Finally, almost in our own day, the atomic theory was introduced into chemistry by Dalton, and its introduction marked an important era in the science. At the present time the doctrine of atoms forms a principal feature in chemistry, and other branches of science find the conception most conducive to the philosophical explanation of phenomena. The definition of an atom given by Demokritos is almost as absolute and precise as that which we find in our most modern treatises. Thus the theory has endured for more than twenty-five centuries, and is likely to endure until there shall be no more science. It offers a striking example of the oneness of physical thought; the conception seems to be essential to Natural Philosophy; the most stupendous phenomena may be referred to atomic motions. S. Augustine has well said, "Deus est magnus in magnis, maximus autem in minimis."

The Hindus not only possessed the idea of the atomic constitution of matter, but further associated an attractive force with the atoms. This is well shown in the following extract given by Sir William Jones, from the poem of "Shi'ri'n and Ferhád, or the Divine Spirit, and a human soul disinterestedly pious":—"There is a strong propensity, which dances through every atom, and attracts the minutest particle to some peculiar object; search this Universe from its base to its summit, from fire to air, from water to earth, from all below the moon to all above the celestial spheres, and thou wilt not find a corpuscle destitute of that natural attractibility; the very point of the first thread in this apparently tangled skein; is no other than such a principle of attraction, and all principles beside are void of a real basis; from such a propensity arises every motion perceived in heavenly or in terrestrial bodies; it is a disposition to be attracted, which taught hard steel to rush from its place and rivet itself on the magnet; it is the same disposition which impels the light straw to attach itself firmly to the amber; it is this quality which gives every substance in nature a tendency towards another, and an inclination forcibly directed to a determinate point."

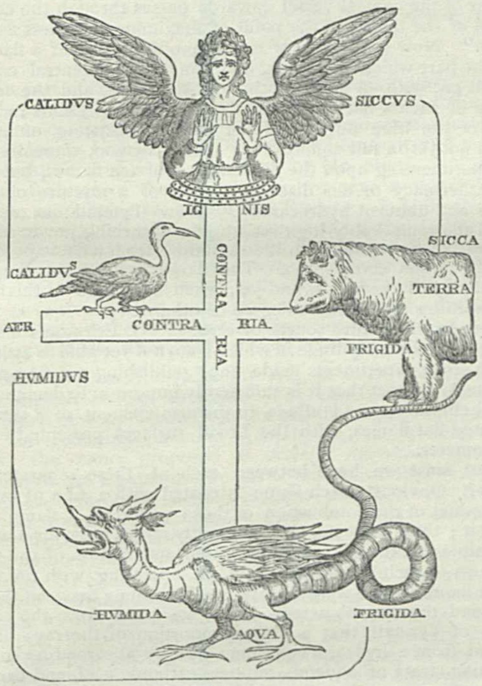
The most prolific writer on Science amongst the ancients was Aristotle (b. 385 B.C., d. 322). He was the author of various treatises, on the Heavens, on Generation and Corruption, on Physics, on Respiration, on Audibles, &c., and his views as well on metaphysics and ethics, as on science, were nearly universally accepted during the Middle Ages. Indeed, the scientific writings of Aristotle influenced science for nearly twenty centuries. Few, however, of his opinions concern us here. He was the first to introduce into Greek philosophy the *ether*, which he regarded as a fifth element (hence afterwards called *quinta essentia*) more subtle and divine than the other elements. The word quintessence is frequently used by the alchemists and early chemists, and is found in our most recent English dictionaries. The idea of an infinitely rarified and all-penetrating matter had long existed in physical philosophy, notably in the Hindu systems; it was probably recognised as a fifth element prior to the ninth century B.C. Aristotle is said to have called it αἰθὴρ from ἀεὶ and θέω, because he conceived it to be always in motion, and to be the moving agency of the other elements; but we cannot admit this derivation now, and prefer to trace it to αἴθω and *indh*. In the present day we find it impossible to explain various phenomena, notably those connected with radiant heat and the polarisation of light, without assuming the existence of some rare ethereal medium, cubic miles of which would not weigh a milligramme, and we still call it the ether. Few physical systems have avoided this supposition; we make less use of it in chemistry than in physics; but it would be difficult to account for such actions as the combination of chlorine and hydrogen under the influence of light, without it. Aristotle held that the four elements are mutually convertible, and he assigned two qualities to each, one of which was common to some other element. Thus he said:—

Fire is hot and dry.
Air is hot and moist.
Water is cold and moist.
Earth is cold and dry.

In each of these one quality is dominant. Thus fire is more hot than dry, air more moist than hot, water more cold than moist, and earth more dry than cold. If the dry of fire be vanquished by the moist of water, air will result; if the hot of air be vanquished by the cold of earth, water will result; if the moist of water be vanquished by the dry of fire, earth will result. This idea of the transmutation of the elements was adopted generally in works on alchemy; the following figure which embodies it is from a work entitled "Preciosa Margarita Novella," published in Venice in 1546.

Aristotle's method of expressing the transmutation of the elements does not seem to differ much from that of earlier philosophers; it would appear that he means to imply that if water be heated air is produced, while if it be heated more strongly so as to evaporate it to dryness, earth is left. His account of the generation of fire from air and earth is based on the most shallow and meagre observation, and shows to what results the most astute mind may be led if unaided by experiment. The generation of fire, he says, is made evident by the senses, for flame is notably fire, but flame is burning smoke, and smoke is from air and earth.

It is not here that we may tell how the philosophy of Aristotle was introduced into Europe by the Arabians, how from it arose that stupendous mass of false philosophy and perverted Aristotelianism called Scholasticism, and how for centuries the blind acceptance of the Peripatetic dogmas retarded the progress of science. Worse than all, Averroës, who has been called "l'âme d'Aristote," and who scattered Aristotelianism broadcast over Europe, did not know Greek, and the Latin versions of Averroës were "Latin translations from an Hebrew version of an Arabic commentary on an Arabic translation of a Syriac version of a Greek text." We may not, therefore, blame Aristotle for the results which followed from the too general and literal acceptance of his philosophy. Mr. Lewes has well said, "However he may have been impelled to systematise on imperfect bases, and to reason where he should have observed, it is not too much to say that had he reappeared among later generations, he would have been the first to repudiate the servility of his followers, the first to point out the inanity of Scholasticism. His mighty and eminently inquiring intellect would have been



Alchemical Representation of the Transmutation of the Elements.

the first to welcome and to extend the new discoveries. He would have sided with Galileo and Bacon against the Aristotelians."

We have spoken above of the endurance of the Thalesian theory, that all things are formed from water, and of the yet older theories of the existence of an ethereal medium, and of atoms; but the theory which affirms that the world is composed of the four elements—earth, air, fire, and water, is yet older, and is, indeed, the oldest physical theory of which we have any knowledge. It certainly existed before the fifteenth century B.C., it was adopted in India, Egypt, and as we have seen, in Greece at a very early date. Then in the case of those philosophers who made water, air, fire, &c., primal elements, this element was first transmuted into the three other elements, and the world was formed from the four. We must be careful, however, to remember that these four elements are not to be understood too literally, they were rather principles or types of qualities than actual elements. Several philosophers divided fire into a purer and grosser part. Seneca tells us that the Egyptians extended the theory by assigning to each element an active and a passive form: thus fire was divided into light which shines, and into fire; air into passive atmosphere and active wind; water into fresh and salt water; and earth into cultivable land on the one hand, and rocks on the other. These elements were extended yet more. In later times *Fire* would come to signify everything appertaining to ignition; thus light, whether accompanied by heat or otherwise, flame, the heat inherent in all bodies, incandescent bodies, stars, fiery meteors, lightning, and all visible manifestations of electricity, would be included under the term. *Air* would include smoke, steam, all vapours, and whatsoever approached to the nature of a gas. When gases were first discovered a hundred years ago, they were called *Airs*; thus we read of *fixed air*, *nitrous air*, *dephlogisticated air*, &c. *Water* would include all liquids, of which, no doubt, blood, milk, wine, and oil, were in early times the most familiar; the words *aqua fortis*, *aqua regia*, *aguardiente*, *eau-de-vie*, &c., are vestiges of the old practice. *Earth* included all rocks, however dissimilar they might be, all kinds of cultivable land, metals, and whatever appertained to solidity. Every solid was regarded as a kind of earth at first. A century ago many substances were called earths. At the present time out of the sixty-five elements known to the chemist, eight are classed as "earths" and three as "alkaline earths." The fact is, the four ancient elements were types of great classes of which the whole world was constituted. In their most general sense, *earth*, *water*, *air*, signified *solidity*, *liquidity*, *gaseity*, while *fire* was the force exercising itself upon matter. We have seen that the elemental fire of Herakleitos is the mover of matter, the principle of movement, that which produces perpetual changes around us. Fire was the ψυχή, the anima, the soul, the vivifying spirit. The mythological side of the belief is seen in the story of Prometheus, who is fabled to have stolen fire from Heaven and therewith vivified mankind. The philosophical side of the belief is seen in the dogmas of Herakleitos. The four-element theory evolved itself from the crude ideas about ether and chaos, mind and matter, before discussed; it is one of those crude physical theories which is enunciated and accepted by races the most diverse in character, country, faith, destiny. There is great oneness in the human mind in the matter of broad principles in crude cosmical ideas. And let us not forget that the four-element theory was universally accepted during the Middle Ages, and was only disproved a century ago, when air was proved to be a mixture of two gases, water a combination of two gases, fire the result of intense chemical action, and earth a mixture of some dozens of elementary bodies, some combined, some single. We do not deny that during the continuance of the four-element theory it may often have been taken in its strictly literal sense; but we do venture to assert that the richer and more cultured intellects regarded it in the light we have above described.

We can quite understand why there was so little natural science among the ancients, when we remember the absence of all experimental method and means, and the obstacle presented by the habit of mind which induced them to apply reasoning in place of experiment in the study of nature, to reason upon an immature or ill-observed fact, and to generalise upon altogether insufficient data. A simple sophistry applied to observation could lead to the most monstrous results. Take, for example, the argument of Diodorus, as given by Sextus Empiricus to prove that nothing is moved:—"If a thing be moved, it is either moved in the place where it is, or in the place where it is not. But not in that wherein it is, because it rests in the place wherein it is; neither in that wherein it is not, for where a thing is not, there it can neither act nor suffer. Therefore nothing is moved." Again, Sokrates and many of his followers taught that it was unwise to leave those affairs which directly concern man, to study those which are beyond his control and external to him. Thus, to inquire into the nature and distance of the stars seems an useless speculation, because even if we could ascertain these things, we could neither alter the course of the stars nor apply them to any benefit of mankind.

We have, however, seen above that many of the Greek philosophers had more or less definite notions concerning matter and force, and that they frequently insist upon the transmutation of matter from one form into another; so far and so far only are we concerned with their dogmas in our inquiry into the Birth of Chemistry. But we must not fail to notice the existence at a very early date of the four-element theory, of an atomic theory, of the idea of an ethereal medium, of the idea of transforming one kind of matter into another by the agency of some motive principle. Neither let us forget to note the similarity of principles in diverse philosophies; thus the homœomeries of Anaxagoras and the atoms of Leukippos are clearly related, so, too, are the νοῦς of Anaxagoras, the ἀνάγκη of Demokritos, the actuating form of fire of Herakleitos, the moving ether of Aristotle. The links which bind together ancient and modern physical thought are strong and enduring, and since they have lasted during the rise and fall of many nations, and during the most profound changes in the mode and tone of thought, it is not unlikely that they will endure as long as the chain itself.

G. F. RODWELL

THE DIATHERMACY OF FLAME

I HAVE just read Mr. Ericsson's paper on "The Sun's Radiant Heat" in NATURE, October 3, p. 458, and find that he has made some experiments on the diathermacy of flame closely resembling those which I made in 1869, and described in chap. viii. of "The Fuel of the Sun" published January 1870. Although the object of our investigations was identical and the method of proceeding very similar, the results obtained are so contradictory that one of us must be quite wrong, and therefore I think the subject demands discussion.

Referring the reader to the engraving illustrating Mr. Ericsson's paper, I may easily describe my apparatus. Like Mr. Ericsson's, there was a gas-pipe from the side of which projected a row of burners, each provided with a separate stop-cock. My burners, however, differed from his in being perpendicular to the main pipe which was always used in a horizontal position. My blackened bulb thermometer was similarly fixed at one end of a chamber or vessel, the other end of which was open to receive the radiations from the flames. This, however, was much simpler than Mr. Ericsson's. It had not the double chamber with intervening wall, nor was it surrounded by water, but was simply a thin tube of tin plate *polished inside* to prevent absorption of radiant heat. The thermometer was insulated from metallic contact with this tube, and thus could only receive heat from it by radiation, which the polishing reduced to a minimum. The sectional form and opening of the tube was made to correspond nearly with that of the presented side of the gas flames, but was somewhat larger.

At first I used Bunsen-burner flames, then flat flames like those figured by Mr. Ericsson, afterwards simple jets formed by the gas issuing from a small pin-hole, the jets being far enough apart to be quite independent; finally a row of such jets so near to each other that they came in contact, coalesced fully, and formed one sheet of flame, the edge of which was presented to the mouth of the polished tube containing the thermometer.

Guided by results obtained in a previous series of photometric experiments on the transparency of flames to their own special radiations, and by the first experiments I made on diathermacy, I relied on the arrangement last described, viz. the coalescing jets. The reason for this will presently appear.

My mode of proceeding differed in another respect from Mr. Ericsson's. Instead of lighting one jet at one end and then another and another in succession towards the thermometer, I always worked with an odd number of flames, and began with the middle jet, then lighted one on each side, next one on each side of those three, then one on each side of those five, and so on. My flames were thus maintained at a constant mean distance from the thermometer.

By means of a well-constructed experimental gas meter, with micrometic regulator, and a minute alarum clock, the supply of gas was accurately adjusted, so that each additional jet, or pair of jets, should consume an exactly equal differential increase of gas. The results obtained were as follows:—

Number of Jets	Consumption of gas in cubic feet per hour	Highest reading of Thermometer
1	1·0	19°·0 Cent.
3	1·5	23°·0 ,,
5	2·0	27°·0 ,,
7	2·5	31°·0 ,,
9	3·0	35°·5 ,,
11	3·5	39°·0 ,,
13	4·0	43°·5 ,,
15	4·5	48°·0 ,,
17	5·0	53°·0 ,,

Here, then, is a serious discrepancy. I get an increase of 4° by the first addition of two flames, and by eight of such additional pairs obtain an increase of 34°, instead of the 32° due to theoretical diathermacy. These 2° of excess (being due to the latter end of the series) I attributed to the increased temperature of my apparatus.

Mr. Ericsson obtained an increase of only 7°·9 instead of 17°·6, the theoretical requirement.

Without any disposition to underrate the value and importance of Mr. Ericsson's researches, I think that in this matter he has been deceived by overlooking some important sources of fallacy.

1. He tells us nothing about the quantity of gas consumed. His jets all issue from the same main pipe, which he describes as supplied with "gas at ordinary pressure." Now with such a supply the quantity of gas burning from each jet would steadily diminish as he turned on the additional jets. On turning the second jet the first would diminish; when the third was turned the supply to both first and second would be reduced; and so on, to an extent depending upon rates of sectional area of the supply pipe to that of the jet holes. If Mr. Ericsson's drawing is made to scale, the error due to this was of great magnitude.

A second source of error is described in Mr. Ericsson's own words; he says, "It will be observed that the prolongation of the axis of the conical vessel upwards passes through the central portion of the flames at the point of maximum thickness and intensity." Now the point of maximum thickness of a flame is just that part which is hollow, and consists of a central core of unburnt gas with an outer coating of true flame, and the central portion of such a flat flame as Mr. Ericsson represents includes much of the blue portion of the flame, consisting of hydrocarbon not yet in full combustion. Mr. Ericsson, therefore, was not experimenting upon the diathermacy of ten flames, but upon the diathermacy of ten discs consisting of a mixture of flame proper and unburnt hydrocarbon. Now Tyndall has demonstrated the remarkably high resisting or absorbing power of such hydrocarbon in reference to the radiations from a flame produced by hydrocarbon combustion. The flame itself might therefore be perfectly diathermous, and yet, when examined in this manner, exhibit a considerable degree of athermacy.

There is still a third source of error in Mr. Ericsson's mode of proceeding, the magnitude of which I am not yet able to estimate, though some experiments made since publishing my first results lead me to suspect that it is sufficiently important to demand very careful elimination. I allude to the arrangement of a series of separated flat flames, with the broad surfaces presented to the thermometer.

What must we have between each of these separated flat flames? Obviously each flame is coated with a film of vapour, the product of the combustion of those portions of flame lying below it; these vapours, though rapidly rising, must form a layer of sensible thickness equal to an important fraction of the whole thickness of such thin flames. When operating with the whole eleven flames, there were twenty-one such films between the first flame and the thermometer. Now, we know from the experiments of Tyndall, that a large proportion of the rays of heat emitted from a hydrocarbon flame will be absorbed by such intervening strata of aqueous vapour, carbonic acid, and carbonic oxide. It is true that the middle or blue part of the flame, having less combustion going on below it, must have a thinner coating of such vapours than the upper part; and thus in Mr. Ericsson's arrangement this third source of error is diminished in the same proportion as the second is increased. It was these theoretical considerations, confirmed by results of preliminary experiments, that induced me to abandon the flat flames in favour of the simple round jets, and finally to adopt the continuous flame formed by the coalescent jets.

As I stated on the first publication of the results of these experiments on the diathermacy of flame, I do not regard them as sufficiently delicate to be finally and quantitatively conclusive; the means at my disposal rendered them less satisfactory than those I made on the transparency of flame. Still, I think they are not open to any such serious sources of error as those I have here pointed out.

I hope that Mr. Ericsson will not be offended by the candour of my criticism, nor by the egotism which is inevitable in an unaffected defence of one's own philosophical bairns.

My experiments, like those of Mr. Ericsson, were made with the direct object of throwing some light upon the great mystery of solar radiation; and the fact that we have arrived at such pposing conclusions will, I hope, lead to further investigation, and finally to a settlement of the important fundamental physical question, whether the properties of flame, in reference to the absorption and transmission of heat and light, are, as I have ventured to suggest, diametrically opposite to those of gases and vapours—whether flames are specially transparent and diathermous to rays of their own emission, and resist the passage of heterogeneous rays; that a flame is thus not merely heated gas, but another and distinct form of matter, or rather is matter in a different state of activity.

If this be established, we shall be driven back upon "the wisdom of the ancients," and be forced to admit the classification of the four elements, "fire, air, earth, and water," or flame, gas, solid, and liquid; remembering, of course, that they used the term "element" with a different meaning to that of our modern acceptation. They described elementary or necessary conditions, not elementary constituents. It was the philosophy of material existence, not the composition of material substances, which chiefly occupied their attention. From this point of view their classification may, after all, prove to be correct.

I must reserve for another communication some remarks I proposed to make on the application of the above to Mr. Ericsson's researches on the radiation of the chromosphere.

W. MATTIEU WILLIAMS

SCIENTIFIC SERIALS

THE part of the *Transactions of the Linnean Society* just published, forming the 2nd part of vol. xxviii, consists of two elaborate botanical papers; "Memoir on the Spermogones and Pycnides of Crustaceous Lichens" by Dr. Lauder Lindsay; and "On the Hippocrateaceæ of South America" by Mr. Miers. Of the important features of the latter paper we gave a sketch on the occasion of its being read before the Society. It is illustrated by seventeen very beautiful plates executed by the author. The first is an extremely elaborate paper, illustrating the great variation in the spermogones and pycnides in the same species of lichen, and even in the same individual. For this purpose as many as twelve or even 20 specimens of the same species, preserved in various herbaria, are in some cases minutely described. This paper is also illustrated by eight coloured plates.

THE *American Naturalist* for August does not contain so many original articles as usual. The Rev. Samuel Lockwood describes a new Entozoon from the eel, belonging to Duvaine's type, the Acanthocephala or spiny-heads, but forming a new genus; the name proposed is *Koleops anguilla*. Dr. J. J. Woodward has a paper on the use of monochromatic sunlight, as an aid to high-power definition; and the Rev. H. J. Bruce describes some of the familiar birds of India. Among the shorter articles there are some very interesting notes.

The number for September opens with an interesting article by Mr. S. H. Scudder, the curious history of a butterfly. The American butterfly *Brenthis bellona* occurs in two different forms produced at different times of the year, in both cases the larva hibernates, but with one set when just out of the egg, with the other when half grown, the butterfly appearing in one case in May, in the other in September; and it seems impossible that these two parallel races of the same species can ever mingle. Prof. N. S. Shaler has a paper on the Geology of the Island of Aquidneck and the neighbouring parts of the shores of Naragenset Bay; and Dr. R. H. Ward sends a microscopical contribution entitled "The new Immersion Illuminator." Mr. C. V. Riley, who has paid great attention to the *Phylloxera* and other diseases of the vine, has some valuable remarks on the cause of the deterioration of some of the native grape-vines, which he has contributed to his report as Entomologist to the State of Missouri.

THE *Quarterly Journal of Science* for October commences with two meteorological articles, the Origin of the Great Cyclones, by Prof. T. B. Maury, and an anonymous paper on Weather Prophecies. The author of the former article considers it proved that cyclones are formed chiefly, if not exclusively, along the edges of the great atmospheric currents, the surface currents and the upper currents alike, the polar streams which descend into our valleys, and the aërial gulf streams which move invisibly over our heads. Capt. Oliver continues his series of papers on the Amorpholithic Monuments of Brittany, and in continuation of a previous series we have an article on Natural and Artificial Flight—an Aërial Ship. Mr. F. C. Danvers, on Paper in the International Exhibition, gives a slight sketch of the history of the manufacture of paper and of the various specimens to be seen in the Exhibition. The Physiological Position of Tobacco, by Mr. E. A. Axon is a powerful attack on the use of the weed as not only unnecessary and destitute of any beneficial results, but positively injurious.

THE first paper in the *American Journal of Science and Arts* for September is by Prof. J. W. Draper, "Researches in Actino-Chemistry," from which we have already reprinted an extract on the distribution of heat in the spectrum. Prof. Shepard concludes his account of the Corundum region of North Carolina and Georgia; and then follows a sketch of Barrande's account of the origin of Palæozoic species. Mr. A. A. Hayes has a long article on the red oxide of zinc of New Jersey. In Prof. O. C. Marsh's continuation of his preliminary description of new Tertiary Mammals are descriptions of a large number of new genera and species.

IN the *Geological Magazine* for October (No. 100), the Editor, Mr. Henry Woodward, gives us notes, illustrated with excellent figures, on some British Palæozoic Crustacea belonging to his order Merostomata. These notes include a full description of *Hemiaspis limuloides*, a species originally established by Mr. Woodward in 1865, and also shorter characters of three other species of the same genus, namely, *H. speratus* (Salt ms.), *H. horridus*, sp. n., and *H. Salweyi* (Salt). These Silurian forms are particularly interesting as they constitute a connecting link between the suborders Eurypterida and Xiphosura.—Of the latter group Mr. Woodward here notices some species of the genus *Bellinurus*, and describes a new form under the name of *B. Königianus*, also a new *Prestwichia*, *P. Birtwelli*, both from the Coal measures.—Mr. W. T. Aveline publishes a short note on the continuity and breaks between the various divisions of the Silurian strata in the Lake district, and Messrs. Davidson and King some remarks on the genera *Trimerella*, *Dinobolus*, and *Monomerella*. In this paper the authors propose the establishment of a new Brachiopod family, Trimerellidæ, allied to the Lingulidæ.—Dr. H. A. Nicholson describes a new genus of fossil tubicolar Annelides founded upon a division of the fossils hitherto referred by Palæontologists to *Tentaculites*. The so-called genus *Tentaculites*, according to Dr. Nicholson, includes forms belonging to the Pteropodous Mollusca and others which are true tubicolar Annelides, the former being free shells, the latter attached to other bodies. He proposes to retain the name *Tentaculites* for the Pteropods, and to establish a new genus, *Ortonia*, for the Annelides. He describes and figures a new species of the latter from the Cincinnati group of the Lower Silurian of Ohio under the name of *Ortonia conica*.—The concluding article in the number is a further instalment of Prof. Nordenskiöld's account of the Swedish Greenland Expedition of 1870.

SOCIETIES AND ACADEMIES

PHILADELPHIA

Academy of Natural Sciences, April 2.—Prof. Leidy made some remarks on specimens of fossils of extinct mammals from the Tertiary of Wyoming. One of these is an upper jaw fragment with two molars; the other a lower jaw fragment with a single molar. The upper molars have crowns composed of four lobes, of which the outer are like the corresponding ones in *Anchitherium*. Of the inner lobes, the front one is much the larger, and is prolonged outwardly in advance of the antero-external lobe. It is homologous with the antero-internal and antero-median lobes as existing in *Anchitherium* in a completely connate condition. The postero-internal lobe is the smallest of the crown. It is conical and conjoins that in front. A barely perceptible trace of a postero-median lobe is seen. A strong basal ridge incloses the crown, except externally, where it is feebly produced. The three upper molars occupied a space of 8 lines. The first molar is $2\frac{1}{2}$ lines fore and aft and $3\frac{1}{4}$ transversely; the second is $2\frac{3}{4}$ lines fore and aft, and the last one $2\frac{1}{4}$ lines. A question arises as to whether these teeth pertain to any of the animals previously indicated from lower jaw specimens with teeth. They are too large for the known species of *Hyopsodus* or *Microsyops*. They nearly accord in size with the lower molars of *Notharctus*, and perhaps belong to this genus. *Limnotherium* appears not to differ from this, as the number of teeth and their constitution are the same. The lower jaw fragment accompanying the upper one may belong to the same animal. The molar it contains, though resembling those of *Notharctus*, differs in several points. I propose to refer the fossils to a species with the name of *Hipposyus formosus*. Prof. Leidy further remarked that he had recently the opportunity of examining the tooth described by Prof. Marsh under the name of *Palæosyops minor*. The tooth evidently belongs to the curious pachyderm with the beaver-like incisors named *Trogosus castoridens*. On observing the molar tooth, which is not worn away like those in the jaw specimen upon which the latter was named, it at once called to mind, the tooth which had been described under the name of *Anchippodus riparius*. On comparison, it would appear as if the specimens referred to *Palæosyops minor* and *Trogosus castoridens*, really belong to the same genus and species. The tooth of *Anchippodus ripparius* was obtained from a tertiary formation, Miocene or Eocene, in Monmouth Co., N.J. If the determination is correct, it would go to show that the Bridger Tertiary formation of Wyoming was contemporaneous with the Tertiary deposit of Monmouth Co., N.J. Prof. Cope stated that the largest mammal of the Eocene formations adjoining those of Wyoming, *i.e.* of the Wahsatch group of Hayden, was the *Bathmodon radians*, Cope, of about the size of Rhinoceros. It was an odd-toed ungulate, with peculiar dental characters. The incisors were well developed above and below, as in the tapir, but the dental series was little interrupted. The crowns of the upper molars were all wider than long, and presented mixed characters. On the outer margin one only of the usual crescents of ruminants was present, but a tubercle represented the anterior one. The one which was present was directed very obliquely inwards. Inner crescents were represented by two angles, the posterior forming the inner angular margin of a flat table, the anterior a mere cingulum at its interior base. The arrangement of these parts was stated to be of interest in connection with the relation ships between the types of hoofed animals. The single outer crescent was a ruminant indication, while the inner table resembled the interior part of the crown of *Titanotherium*. It differed, however, in its early union with the outer margin, its edge being thus possibly homologous with the posterior transverse crest in *Rhinoceros*. The premolars had two or three lobes with crescentic section arranged transversely. He regarded the genus as allied to *Chalicotherium*. He stated that the mammalian fauna of Wyoming and Utah more nearly resembled that of the Paris Basin than any yet discovered in our country, and that it had been discovered to contain a still greater number of generalised mammalian forms. One of the most marked of these was the genus just described by Dr. Leidy.

PARIS

Academy of Sciences, September 30.—M. Chevreul, president.—The following members of the International Committee on the Metric System were present at the meeting:—MM. Stankart and Bosscha, for the Low Countries; Mr. Chisholm, for England; General Ibanez, Spain; MM. Lang and Herr, Austria. The following papers were read:—"On the demonstration of the formula which represents the elementary action of two currents," by M. J. Bertrand, a long mathematical paper on Ampère's law of electrodynamical attractions; "On the immediate determination by the principle of correspondence of the number of points of intersection of two curves of any order which meet at a finite distance," by M. Chasles.—Next came a note on the stability of colours on stuffs in general, and on silk in particular, by M. Chevreul. The author refers to a paper he read before the Academy twelve years back, when he drew attention to the unstability of many of the aniline colours then recently introduced. He now again calls attention to these colours, and considers that the use of them cannot fail to have a disastrous effect on French commerce and industry.—A paper by Father Secchi followed, entitled, "Solar Spectroscopic Researches." The author calls attention to the following extract from a letter to Herr Schellen, written by Mr. Young, of Dartmouth College, U.S. A. Mr. Young was stationed on Mount Sherman, 8,300 feet above sea level, and used a telescope of 9·4 inches aperture. He says, "The spectrum of the sun, although not entirely reversed at the border of the disc, became continuous, as Father Secchi has seen in Italy. When the air is calm the height of the region where this occurs is not greater than 1″. The lines rays of the chromosphere were remarkably augmented in number. H_1 and H_2 were seen reversed, as was h and the other hydrogen lines. In the spectrum of each spot the lines of hydrogen were reversed in a region slightly more extended than the penumbra; this has been verified for at least twenty different spots." Father Secchi states that these observations confirm his own made at Rome in 1869.—M. Bertrand then presented the Academy with a posthumous work of M. Duhamel, entitled "An Essay on the application of scientific methods to the moral man," upon which he made some remarks. He was followed by M. Max Marie's concluding paper "On the theory of the residues of double integrals." Next came M.M. A. Rabuteau and F. Papillon's "Researches on the Physiological Action and Antifermentable properties of Sodic Silicate." The authors have added various quantities of this body to different kinds of fermentable matter and find a quantity of two grammes to completely stop all fermentation of whatever kind. Its action is exactly analogous to that of borax but more energetic. Two grammes of the latter injected into the veins of a dog produced no effect whilst one gramme of the silicate produced violent purging and vomiting and ultimately death after an interval of nine days.—On the effect of vegetable parasites in altering bread by M. M. F. Rochard and Ch. Legros was referred to the commission appointed to examine the *Oidium aurantiacum*. M. Bertrand then presented a note "On the movement of the Planets around the Sun according to the Electrodynamic Law of Weber," by M. F. Tisserand. M. Yvon Villarceau presented a note by M. Stephan on the "Elements and Ephemerides of Planet 122. M. Yvon Villarceau remarked that M. Stephan had also calculated the orbit of 121, and he then presented a note by M. R. Luther, on an "Observation of the Planet 95, Arethusa, made at the Observatory of Bilk-Düsseldorff," which was followed by a note of M. Trève, "On Magnetism."—M. Milne-Edwards then presented a note by M. N. Joly, entitled, "Observations on the Metamorphoses of Osseous Fish in general, and particularly on those of a small Chinese fish of the genus Macropoda, recently introduced into France."—This was followed by a paper by M. H. Sicard, "On the Connection which exists between the Nervous and Muscular Systems in the Helices."—And then came a note by M. Lichtenstein, "On a Process for the Destruction of *Phylloxera*," by the burying and subsequent destruction of the young shoots. Papers on the same subjects were received from MM. A. Rainaud, Peyrat, and Louvet, and were sent to the Phylloxera Commission.

PAMPHLETS RECEIVED.

ENGLISH.—The Philosophy of Theism: J. Croll. —Quarterly German Magazine, No 2.—Proceedings of the Bath Natural History Society and Antiquarian Field Club, Vol. ii. No. 3.—Proceedings of the Liverpool Naturalists' Field Club, 1871-72.—The Geology of the country around Liverpool: G. H. Morton.—Notes for my Students in Magnetism: W. J. Wilson.—Annual Report of Committee for amending the law with respect to the property of married women.—Journal of Mental Science, October.—Quarterly Journal of Science, No. 34.—Heywood's School Atlas of Twelve Maps.—Pyrology, or Fire Analysis: Captain W. A. Ross.—Journal of the Statistical Society, September.

AMERICAN AND COLONIAL.—Canadian Naturalist, Vol. vi. No. 4.—Popular Science Monthly, October.—Preliminary Description of New Tertiary Mammals: O. C. Marsh.—Notice of some new Tertiary and Post-tertiary Birds: O. C. Marsh.—Proceedings of the Academy of Natural Sciences, Philadelphia, January—April 1872. —Washington Observations for 1870; Appendix II. Report on the Observations of Encke's Comet during its return in 1871: Hall and Harkness.—The Curious History of a Butterfly: S. H Scudder.—Proceedings of the Asiatic Society of Bengal, August.

FOREIGN.—Verhandlungen der k. k. geologischen Reichsanstalt zu Wien, August 30.—Sulla incinerazione dei Cadaveri: G. Polli.—Zeitschrift für Meteorologie, September. —Sur la mesure des sensations physiques: J. Plateau.—La Belgique horticole, July—October.—Om Echinoideerns bygynad: S. Loven.

CONTENTS