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THURSDAY, MAY 9, 1872

MENTAL DARKNESS IN HIGH PLACES

WE have long ago been told in the most forcible language and by the highest authority what will be the fate of a people whose leaders are blind; and the same authority has likewise informed us that the worst possible form of darkness is that in which we think we see. To have a one-sided, a short-sighted, or a distorted view of any principle or policy is frequently worse than not to see it at all, more especially in those who claim to wield the national power or to direct the national will. To have a short-sighted steersman is very bad, especially if the navigation be dangerous; but what must be the fate of the vessel if her steersman and look-out are both equally short-sighted?

It is at the present moment a point of vital importance that our leaders should be well informed as to the true nature of the claims advanced by Science for a better recognition by the Government of this country. Yet we question very much whether the leaders of Government have a just conception as to what is demanded by men of science, and why it is demanded, nor do we think that some of our leading journals are much better informed.

We quote the following extract from the *Times* of April 26, referring to a speech made by Mr. Gladstone at the annual banquet of the Civil Engineers :—

"'A fair field and no favour' is the maxim of English administration. A field so fair, so extensive, and so promising, that all industry may find its place, and such an absence of favour that one as well as another may hope for success. If under such conditions of Government the State 'does nothing for Science,' it cannot be helped, nor need it be much lamented, considering how very little Science stands in need of the aid."

We will do Mr. Gladstone and the *Times* the justice to own that these sentiments embody much that is true. To be meddling and muddling in private concerns is certainly not the province of any Government; and some think that the present Government were wrong when they undertook the management of the telegraphs.

The State should neither on the one hand attempt too much, nor on the other hand should it neglect to perform its obvious duties. What, then, are the principles which should guide a conscientious and intelligent Government as to its action in such matters? There can, we think, be no doubt as to these principles. If a certain course of procedure be for the obvious benefit of the whole people, and if its accomplishment be beyond the power of private associations, but not beyond that of Government, then surely it ought to be undertaken.

Let us test the truth of this maxim by one or two illustrations. It is for the obvious benefit of this country that it should have good steam communication with the continent of Europe and with America. Nevertheless our steam packets ought certainly to remain as they are, in the hands of private companies. Natural laws may here be left to themselves, and they will doubtless work in such a manner that the companies will on the one hand receive a handsome profit, while the public will on the other hand be supplied with efficient steam communication.

Again, it is of great importance that the country should be well furnished with animal food, and here, as before the task of supplying it may with advantage be left to private enterprise.

But in connection with this supply, we come to a case in which Government have very properly interfered. It is very important that the meat should be good and wholesome, and that diseased cattle should not be imported. On the other hand the people themselves, apart from Government, have no power of stopping the importation of such cattle, and therefore Government have very properly come forward and lent their aid in securing to the people a thoroughly wholesome supply of animal food.

It will at once be seen from these and similar instances, that legislative interference is uncalled for wherever natural laws are at work to perform the required objects.

Such natural laws are in operation in all, or nearly all, of the arts and industries of life. To meddle with carpenters, or bricklayers, or shoemakers, is entirely beyond the province of Government. If a man has a genius for improving shoes, he must not expect Government to start him in business; but he must look around for the cooperation of a capitalist; in fact, he must carry his genius to market and dispose of it to the highest bidder.

But what if the man have a genius for discovering natural laws? Will Mr. Gladstone or the *Times* be good enough to indicate the whereabouts of the market in which his genius will be rewarded? We have just been told that it is not at the Treasury; well, but where is it? Or will they tell us that such a discovery will never be of any practical advantage? Hardly so; the time for saying such things is past. It will in all probability be of immense importance to all industries, and they will all derive much profit in consequence of this man's discovery; yet he himself will derive none.

But we need not here attempt to prove that the advancement of Science is a question of national importance. This has been already demonstrated very conclusively by Col. Strange and others who have recently devoted much attention to the subject. We pass on to consider whether its advancement can be undertaken by private bodies, such as the Royal Society or the British Association.

The recent actions of these bodies speak for themselves. The former has just discontinued a series of sun observations taken under its superintendence; while the latter has given up the maintenance of the Kew Observatory—both on the plea of want of funds. Again, the maintenance of meteorological observatories has already been undertaken by Government as a thing beyond the means of private individuals.

In all directions the spread of Science is cramped by this want of money; to illustrate which we shall conclude by giving a short account of the recent attempt made by the British Association to establish a series of electrical standards on a scientific basis. One of the most important, and at the same time most difficult, determinations was that of the unit of resistance. In order to establish this unit upon the principles proposed by Weber and Thomson, it was necessary to associate together in an experimental investigation a scientific electrician, a mathematician, a metallurgist, and the director of a magnetic observatory. It was necessary first of all to determine the best kind of wire in which to embody the standard, and this required numerous experiments by a metallurgist; it was necessary to know what changes took place in the magnetism of the earth during the experiments, and this required the attendance of the director of a magnetical observatory; a scientific electrician presided over the experiments, and associated himself with a mathematician who was well versed in the theory of electricity. The unit of resistance thus determined by the British Association has now been universally adopted by practical engineers; men of science have laboured, and the Postmaster-General has quietly entered into the fruits of their labour; but the experiments in connection with other units are not yet finished; in fact such researches, requiring as they do great skill and time for their accomplishment, must necessarily hang fire if the men who can perform them do not receive some support which will enable them to devote their best energies to the conduct of these and similar experiments.

We have now said enough to establish our point that the extension of Science is of national importance, and that in its present state this extension is beyond the means of private individuals, but not beyond the means of the State. Before concluding, we ought to mention (more especially since it cannot be gathered from the *Times* report) that one of our most distinguished men of science, Dr. Joule, was present at the banquet to which we have alluded, and in returning thanks for Science took the opportunity of stating that he trusted Science would soon obtain that recognition which it imperatively required. If men of science will be true to themselves and to their noble cause, we feel confident that sooner or later they will prevail.

HOOD ON BONE-SETTING

On Bone-Setting. By Wharton P. Hood, M.D., M.R.C.S. (Macmillan and Co., 1871.)

TO any but the professional reader this title is not attractive; and yet we are greatly mistaken if the book itself does not prove to the full as attractive and as lastingly interesting to the intelligent non-professional as to the professional reader; and this, not because the subject is lowered to the level of general comprehension, or written in what is called a "popular" style, but simply because the subject itself is of such wide and varied interest, and its whole treatment in the present little volume is so frank, so clear, and so convincing.

It will be asked, What is bone-setting, who are the bone-setters, and who are their patients? And it will be readily answered, Why, of course, bone-setting is the art of setting bones that have been broken, or joints that have been dislocated, and this is done, doubtless, by surgeons; and equally doubtless and of course, their patients are persons whose bones are fractured, or whose joints are dislocated—

There needs no ghost come from the grave to tell us that.

Perhaps not, but the answer is quite wrong for all that; quite the reverse indeed of what is actually the case, for bone-setting is *not* the art of re-setting broken bones or dislocated joints; bone-setters are *not* surgeons, or regular practitioners in any sense of the title; and their patients, even when they have suffered injury to joint or bone, have been pronounced by the regular practitioner *cured* before seeking the help of the bone-setter.

Having stated this triple paradox, let us hear what Dr. Hood has to say in explanation.

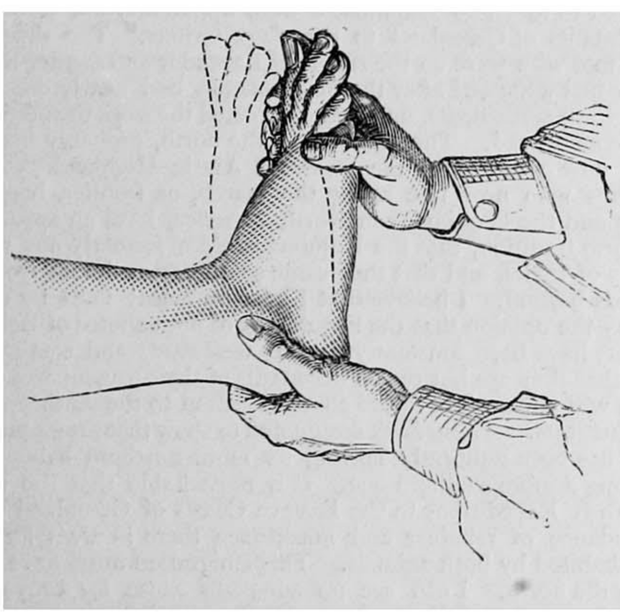
"A healthy man sustains a fracture of one or both bones of the fore-arm, and applies at a hospital, where splints are adapted in the usual way. He is made an out-patient, and the splints are occasionally taken off and replaced. After the lapse of a certain number of weeks the fracture becomes firmly united, the splints are laid aside, and the man is discharged as cured. He is still unable to use either his hand or his fore-arm, but is assured that his difficulty arises only from the stiffness incidental to long rest of them, and that it will soon disappear. Instead of disappearing, however, it rather increases, and in due time he seeks the aid of a bone-setter. . . . The bone-setter would then by a rapid manipulation, hereafter to be described, at once overcome the stiffness of the fingers, and enable the patient to move them to and fro. The instant benefit received would dispel all scruples about submitting the wrist and the elbow to manipulation, and these would be set free in their turn. The man would go away easily flexing and extending his lately rigid joints, &c."

Now what was the cause of stiffness in the foregoing typical case? What was the nature of the impediment to normal movement, ignored by the surgeon and overcome by the bone-setter? The impediment above indicated, it is argued, might arise from articular inflammation, producing adhesions between surfaces "resting in apposition," and that such adhesions, if so placed as to restrain movement, will cause pain and irritation whenever they are rendered tense; and, moreover, that inflammation sufficient to produce these adhesions may be insidiously set up in a joint by extension from neighbouring structures—as in the above-recited case. Again, it is argued, "possibly in some cases, the proper ligaments may become contracted or rigid, or adherent to neighbouring parts; in others, internal or external adventitious fibrous bands may be formed; in others, muscles may have undergone shortening. Again, effusion may have become solidified, and thus movement be impaired, as if by a state of things analogous to a rusty hinge." And further on: "If we consider the amount and character of the effusion which takes place after some sprains and injuries, in some gouty and rheumatic affections, and in some cases of suppuration occurring in bursa, or beneath deep fascia, we cannot doubt that such effusion may easily assume forms in which it will tie down muscles, tendons, or even articular nerves themselves."

The art of bone-setting, then, is the art of overcoming these impediments in joints, these conditions of arrested or impaired freedom which not unfrequently supervene on the curative processes of treatment in use by surgeons in cases of fracture or dislocation; or which may arise from, and be observed only after the subsidence of, active rheumatism, gout, ganglionic swellings, or other local affections; and this brings us to the question, How is it done? how are these stiffened joints set free? how are these impediments to healthy action overcome? The answer of the regular practitioner is that which has been already quoted, namely, to rest it—advice which usually entails a distressing failure; the answer of the irregular practitioner, *i.e.*, the bone-setter, is precisely the opposite, namely, that freedom can only be restored to the stiffened joint by movement, by manipulation, and manipulation too of the most formidable kind, nothing less than suddenly and forcibly rupturing, tearing asunder, the adhesions formed between the articulating surfaces of the affected joint, an operation which is so frequently successful that it forms the very basis of the bone-setting craft.

It is here that the bone-setter steps in front of the scientific surgeon, and we must confess to a feeling of disappointment that their relative positions are not reversed, that the surgeon is not called in to rectify the malpractices of the quack, instead of the latter being sought out to complete the shortcomings of the former. Let us see how this manipulation is performed. The bone-setter has a clearly defined system of treatment for each separate joint, if not for each specific affection to which each joint is subject. Next to the list of authenticated cases of successful treatment, this is, perhaps, the most valuable part of the treatise; for in addition to the ample and detailed modes of procedure with each joint, diagrams showing the act of manipulation are given, taking in succession those of the upper and lower limbs, and also of the several regions of the spinal column. One example may here be given :—

"The proximal side of the affected joint being firmly held, and the thumb-pressure made in the ordinary way, the tarsus is so grasped as to give the greatest attainable leverage, the foot twisted a little inwards or outwards,



then sharply bent up upon the leg and again straightened. As a rule it is desirable to execute this manœuvre twice over with an inward and once with an outward twist, and also to take care that the movements of the joint are free in all directions."

Bone-setters, we are told, are for the most part uneducated men, wholly ignorant of anatomy and pathology; but we are not told what we greatly wish to know, and that is, the manner and method in which the secrets, the mysteries, and the traditions of their craft, are communicated to each other. No doubt there exists a freemasonry in the craft, so that when individual members meet revelations are made and notes compared, but we are not informed of any regular or organised system of instruction, either for the maintenance and extension of the craft, as a craft, or for the enlightenment of the separate and detached members of the fraternity. The most celebrated, we may even say distinguished, bone-setter of our day was the late Mr. Hutton, whose successful treatment of cases that had baffled the skill of the foremost surgeons now living, cases related in detail by Dr. Hood, and about the accuracy of which there can be no question or doubt, is little short of marvellous; and the question is ever recurrent while we read, "How and where was this skill acquired?" for a bone-setter of Mr. Hutton's calibre could put his finger on the spot where lurked the seat of an affection that had crippled a patient for half-a-dozen years, and had defied the scientific treatment of the ablest surgeons of our time; nay, he could point to this spot without ever seeing the limb affected, guided merely by observing the attitude, gait, or action of the patient. Now, whence comes this undoubted skill of these illiterate men? It appears to be obtained solely by observation of symptoms and results of treatment, the accumulated knowledge of from day to day experience; and as we often see that one sense is quickened and functional power increased by the loss or impairment of some other sense, so perhaps the narrowing of the field of instruction, the limiting of the sources of information, may have intensified the powers of observation of the bone-setters, atoning in a measure for the absence of the revelations of science.

It was from Mr. Hutton himself that Dr. Hood received the secrets of the craft. The motive for, and the manner of, making this revelation are so interesting, that we must give them in Dr. Hood's own words :—

"About six years ago my father, Dr. Peter Hood, in conjunction with Dr. Iles, of Watford, attended the late Mr. Hutton, the famous bone-setter, through a long and severe illness. On his recovery my father refused to take any fees from Mr. Hutton, out of consideration for the benefit which he had rendered to many poor people. Mr. Hutton expressed himself as being thereby placed under great obligation, and as being very desirous of doing something to show his gratitude. He offered as an acknowledgment of the kindness he had received to explain and show all the details of his practice as a bone-setter. Pressure of work prevented my father from availing himself of this offer, and Mr. Hutton then extended it to me. After some consideration I determined to accept it, and accordingly I went, when I could spare the time, to Mr. Hutton's London house, on the days of his attendance there. My decision was prompted, not only by the curiosity I felt to see how he treated the cases that came under his care, but also by the desire to make known to the profession, at some future time, any insight that I could gain into the apparent mystery of his frequent success."

By this means Dr. Hood in time found himself, as he tells us further on, able to take charge of all Mr. Hutton's poorer class of patients, "whom he was accustomed to attend gratuitously," and found that he could accomplish all that he had seen done. "And this practice," he elsewhere emphatically says, "gave me knowledge of a kind that is not conveyed in ordinary surgical teaching—that when guided by anatomy is of the highest practical value, as well in preventive as in curative treatment."

With this knowledge, thus acquired, the author's course was clear. In a series of letters in the *Lancet* he communicated to his professional brethren some of its most important facts, and now to the general reading public he submits the whole in the shape of a well-arranged and clearly-written volume.

ARCHIBALD MACLAREN

OUR BOOK SHELF

Worms; a Series of Lectures on Practical Helminthology, delivered at the Middlesex Hospital, by T. Spencer Cobbold, M.D., F.R.S. (London: Churchill, 1872.)

These lectures do not pretend to give any very minute anatomical details, or any full account of the life history of the remarkable group of animals of which they treat, and which Dr. Cobbold has so long and so carefully investigated. They were originally delivered to medical students, but are so simply and clearly written that they might advantageously be read by the public. They show the frequency with which parasites occur in man, and the necessity of careful supervision of the animal food exposed in our markets for sale, especially at night and to the poor. Dr. Cobbold remarks that the terms "measly mutton" and "measly beef" are terms which will sound strange to those who know of no other "measled meat" than pork; but he points out that his investigations have incontestably proved and verified the existence of larval tapeworms in the most esteemed kinds of animal food. The tapeworms derived from these three kinds of meat, beef, mutton, and pork, though agreeing in their general characteristics, yet differ in minor points, and especially in the shape of their heads. The head of the beef tapeworm is destitute of hooks, and has four large suckers, besides a supplementary fifth (so called); whilst the head of the pork tapeworm is a trifle smaller, and furnished with a slightly prominent proboscis, armed with a double row of hooks. The mutton tapeworm is also armed, at least the "measle" is provided with hooks. A fully-developed beef tapeworm numbers about eleven hundred joints, and attains its full development in about thirteen weeks or rather less. Dr. Cobbold appears to regard the well-made ethereal extract of the root of male fern as by far the best remedy for tapeworm, though kousso, kamala, turpentine, panna, pumpkin seeds, betel nuts, and the bark of the pomegranate, are occasionally successful in effecting their expulsion, and will sometimes accomplish this when the oil of male fern has failed. In regard to thread worms (*Oxyuris vermicularis*) Dr. Cobbold states that it is quite a mistake to suppose the lower bowel or rectum forms their special habitat. He recommends santorine, with active saline purgatives, and copious enemata, for their removal. The large, round worm, *Ascaris lumbricoides*, and the *Ascaris mystax*, are in his experience rare, the latter, indeed, very rare in England, but they are endemic in some regions, as in the Mauritius. The Trichina appears to have been only once recognised and treated in the human subject, namely, by Dr. Dickenson, of Worthington. In this instance Dr. Cobbold calculated that the patient played the host to forty million of the parasites. He observes that when once the Trichina has gained admission to our muscles, all hopes of dislodging it are at an end; but if a person suspects that he has eaten diseased or trichinised meat, he should lose no time in seeking assistance. Immediate advice, followed by a suitable antitrichinalic, might be the means of saving his life, whereas a few days' delay would perhaps prove fatal. Whilst the worms are in the intestinal canal we can get rid of them, but when once the trichinal brood migrates into the flesh no means are known by which their expulsion can be effected. The work terminates with some amusing cases of spurious worms.

H. P.

LETTERS TO THE EDITOR

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

Recent Climatic Changes

In two previous letters I have tried to show that the land is gaining on the sea at both poles; in other words that the periphery of the earth is being thrust out in the direction of its shorter axis. If this change has been so great as to make it probable that the Classical and Arabic accounts were correct when they made Scandinavia an archipelago in the earlier centuries of our era, we may be sure that it has not been without material influence upon other physical phenomena, and notably upon climate.

One obvious result of the conversion of a great space of water into an area of dry land in the high latitudes confined by the Arctic and Antarctic circles, would be to alter very materially the mean climate of both hemispheres. This has been noted by many inquirers into the subject, and not least by Mr. Hopkins in his very ingenious criticism of the different potential climatic revolutions which are consistent with the presence or absence of certain elements like the one we are dealing with. Ingenious and most interesting as Mr. Hopkins's well-known paper in the *Geological Transactions* is, it does not, I think, quite explain facts as observed. I am not writing in emulation of one who has every claim to be considered an authority, but in the humbler guise of a student whom you are always willing to assist, who desires some of your correspondents to throw light on a difficult and neglected question.

The increase of land at the poles at the expense of the water will tend to intensify the extremes of temperature in winter and summer, and in consequence, to make the climate much less constant and uniform and much more severe; and we ought to find evidence of this somewhere, if the premisses of my two previous letters are tenable. I wish to adduce a few facts in the way of such evidence, and to ask your correspondents for more either pro or con. Many such must exist.

Greenland is a name which seems ironical under present conditions of climate. It has always seemed to me that the land there has changed its appearance very considerably since that name was applied to it. The Esquimaux were apparently not known as inhabitants of Greenland to the Saga writers. The skzellings they met with were on the coasts of Labrador and farther South. They first appeared after the black plague had nearly destroyed the Norse settlements, and they completed the work the pestilence had commenced. They came from the north, probably from the area now occupied by the so-called Arctic Highlanders. The Indians who now live along the march, or frontier, bounding them and the Esquimaux in North America, have an apparently uniform tradition, that the Esquimaux were formerly not neighbours of theirs, and that they came south across the sea from the islands beyond. I believe that I have sufficient facts by me to justify the opinion that the Esquimaux of both shores of Behrings Straits have been constantly drifting westwards and southwards, and that they are but recent occupants of their present area there. This will appear in a future communication to the Anthropological Institute. These facts are quoted to show that the Esquimaux race has been uniformly leaving its more northern habitat and seeking a more southern one. It is remarkable that the recent Swedish Expeditions to the Eastern Coasts of Greenland found abundance of reindeer and musk-oxen there in areas formerly uninhabited by both animals. This emigration must have come from the north. I can see no adequate cause for a revolution affecting men as well as other animals in such a uniform manner, except the continuously increased severity of local climates which has driven the inhabitants farther south.

Iceland has notoriously become more harsh and untenable in its climate since the days of the Norsemen. I will quote from a capital authority, Henderson's Journal in Iceland, pages 6 and 7:—"It is evident from ancient Icelandic documents that on the arrival of the Norwegians, and for centuries afterwards, pretty extensive forests grew in different parts of the island, and furnished the inhabitants with wood both for domestic and nautical purposes. Owing, however, to the improvident treatment of them, *and the increased severity of the climate*, they have almost entirely disappeared, and what remains scarcely deserves any other name than that of underwood, consisting for the most part of birch, willow, and mountain ash. That grain was produced in former times in Iceland appears from the names of many places, such as akkrar, akkrances, akkraheron, &c., the word *akr* signifying a cornfield, and from certain laws in the ancient code, in which express mention is made of such fields, and a number of regulations are prescribed relative to their division and cultivation." Grain is no longer raised there. The Black Death, and other reasons, have been adduced for this cessation; but these are clearly inadequate causes, the real reason being no doubt the same which has caused grain culture to be discontinued elsewhere, namely, the increased severity of the climate.

What is true of Iceland is also true of Norway, in the most northern parts of which we find many names compounded with the Norse word for barley, proving, as the best authorities agree, that barley then grew where it grows no longer. In Scotland many places show signs of the plough, and of having been sown with cereals where arable farming is now unpractised. It is notorious that not only in Scotland, but even in England as far south as Lancashire, large districts that were once covered with forests are now entirely bare of trees, and not only so, but trees cannot be made to grow there. "The Romans planted vineyards and made wine in parts of England where the hop will now hardly grow."

In Northern Russia beyond the Dwina there is a vast area, formerly known as Biarmia, studded with the graves and other remains of a very prosperous people, whose wealth and civilisation are much descanted about by the Saga writers. Othere, the navigator, whose story was translated by Alfred, tells us that it was on arriving in their country after the dreary voyage round the North Cape, that he first again met with tilled fields and an agricultural race. This area is now deserted except by a few hunters and fishermen; the ancient inhabitants have moved westward and southward into Finland, &c. I have described the migration in a paper to be printed by the Anthropological Institute. The best authenticated case of this desolation is the increased severity of the climate, which makes agriculture almost unendurable there. The Norse traders used to frequent Cholmogorod, the port of Biarmia, in great numbers, both for traffic and for fishing. This navigation continued until the early part of the thirteenth century, when we are told it was gradually put an end to by the increased difficulties with the ice in the White Sea, which becomes practically choked with ice; and when the English found their way to Archangel in the sixteenth century, so forgotten was this old trade, that the journey was treated as one of discovery.

Farther east facts are less accessible. The following quotations from von Wrangel's voyage illustrates my position :—

"In 1810 Hedenstrom went across the tundra direct to Utsjansk. He says, 'On the tundra *equally remote from the present line of trees* among the steep sandy banks of the lakes and rivers, are found large birch trees complete with bark, branches, and roots. At first sight they appear well preserved, but on digging them up they are found to be in a thorough state of decay. On being lighted they glow, but never burst into flame. The inhabitants use them for fuel. They call them Adamoushtshina (*i.e.* of Adam's time). *The first living birch trees are not now found nearer than* 3° *to the south, and then only as shrubs.*' . . . 'Another cliff, 30 or 35 feet high, beyond the Malaya Kurspataschnaja river, consists of ice, clay, and black earth. On drawing out some interspersed roots we found them to be birch, and as fresh as if only just severed from the trees. *The nearest woods are* 100 *versts off.*'" These facts show how far to the south the limit of trees has been pushed quite in recent times in Siberia, that is, how much more severe the Siberian climate has become—a fact, perhaps, connected with the persistent south-westerly drifting of Ugrian tribes from this area which has taken place during the historic period. The flora of our own bogs must disclose evidences of some kind on this subject. I should be thankful to any of your correspondents for facts which illustrate the question drawn from this or any other source.

Will you allow me to correct two printer's errors in my last letter. Africa has been inserted instead of Arica, and Mine Journal instead of Same Journal, *i.e.*, Journal of the Geological Society. Both errors due to my execrable writing.

HENRY H. HOWORTH

A New Mode of taking Casts

IT has been suggested to me that an account of "A New Mode of taking Casts," reported in NATURE, May 2, 1872, might convey the impression that I claimed any share in the invention. Modelling wax has been employed for this purpose in France by the late M. Edouard Lartet, and I have to thank Prof. Busk, F.R.S., for having first brought the use of the material before my notice. My sole object was to formulate the process according to my own experience of its utility, that it might be employed by others for the multiplication of type specimens, without any idea of claiming its invention.

W. BOYD DAWKINS

Norman Road, Rusholme, Manchester, May 3

The Denudation of the Mendips

IN the address of the President of the Geological Society of London reported in NATURE No. 129, page 490, it is stated that "Denudation has removed from the crest of the Mendips a mass of strata possibly equal to two miles or more in height, and from that of the Ardennes as much as three or four miles."

Could you find space to inform me by what reasoning or on what data geologists arrive at such a conclusion, and whether it is considered that the level of the surrounding district was raised in a corresponding degree, or that the Mendips were isolated mountains, somewhat like the Peak of Teneriffe, rising abruptly from the plains below?

INQUIRER

P.S.—Perhaps by inserting this letter and reply you may convey information to others as well as myself.

Segmentation of Annulosa

MR. RAY LANKESTER, in his letter on "The Segmentation of Annulosa" in NATURE of the 4th ult., appears to maintain that there is no fundamental difference between the segmentation of annelids and that of chitons. He says of the latter, "Why should there not be segmented molluscs?" I can no more answer this than I could answer the question why there should not be hexapod vertebrates. There is nothing impossible or absurd in the idea of the segmentation of chitons being essentially similar to that of annelids; the question is whether it is really so. He says, "The larva of a chiton is (in appearance) identical with that of an annelid, and its segmentation makes its appearance in the same way." This is an important argument, but not conclusive. If, as I believe, Mr. Spencer's theory of the origin of the annulosa is true, the segmentations of the two are fundamentally distinct phenomena, and it might appear that their development should be unlike. According to that theory, the segments of the ancestor of the annulosa had their origin by budding backwards from the head; while the segmentation of the chitons has from the first been "superinduced" like that of the spinal column of vertebrates. But it is admitted that the annulosa do not in their actual development show decided traces of this origin. I think, however, this last fact may be explained by a principle which Mr. Spencer lays down somewhere, with great probability, as a general law (though of course it is a law of tendency only, and may be subject to exceptions), namely, that there is a general tendency to the substitution of direct development for indirect. Thus, the segments of annulosa may have been originally formed one after the other by budding backwards, and yet may now be formed simultaneously, or nearly so, by the segmentation of a vermiform larva.

The opinion that the two cases are distinct is, I think, very strongly confirmed by the fact that annelids still propagate by budding off young annelids from their tails, while no mollusc whatever is known to do so.

JOSEPH JOHN MURPHY

Brittany Dolmens and Tumuli

IN NATURE for May 2 Captain Oliver advocates the theory that dolmens are merely the skeletons of original chambered tumuli. This, I think, scarcely agrees with the fact to be observed in the principal dolmens and tumuli of Finistère. In most cases in that department the dolmens occupy situations in every respect similar to those in which the tumuli are found, so that meteorological, and, indeed, every other but human agencies, must have affected both in the same manner and degree. Notwithstanding this, the dolmens are invariably bare, and the kists are as constantly covered—there are no signs of even incipient degradation and denudation in the latter, and none of former covering in the first. It would be unwarrantable to suppose that had the dolmens been uncovered by human beings, no vestiges of the mounds would remain, or that, this perfect and unaccountable removal of material being allowed, the skeleton, *i.e.*, the part containing the most useful stones, should be left unscathed.

There is, however, a more important point of difference between dolmens and the barrow kists; namely, that in the chambered tumuli there is almost always present a floor-stone—a part of the structure which I have never seen at the base of any of the dolmens of the region in question. And there can, in their case, be no chance of removal, as the floor-stone would necessarily be the last to remain in its place. The dolmens, again, as a rule, were evidently erected with no attempt at nice adjustment of the sides or top, whereas tokens of some care and trouble are to be found in the way in which most of the entombed kists are built.

In these remarks I have limited my observations to those dolmens and covered chambers which are of the simplest grade, but they would, I think, be equally applicable to the more complicated structures similarly circumstanced. It seems, therefore, premature to apply the term "dolmen mound" to such barrows as Carnoët, for instance, where the small and accurately-made kist bears no resemblance to the frequent dolmens of the district.

Harbottle, Rothbury, May 4 G. A. LEBOUR

The University of Freiberg

MAY I be allowed to ask in your pages for information about the University of Freiberg in Saxony as a place of instruction in Geology, Mineralogy, and Chemistry? I should also be glad to know which German Universities are held to be the best for learning these three subjects, and when their terms end. Any information on these points will oblige,

Cambridge University, May 5 UNDERGRADUATE

Sources of Sandstone

YOUR geological readers will readily admit the importance of any hint that will assist them in determining the source from which a particular bed of sand or sandstone has been derived.

How to discriminate between sand produced by the breaking-up of quartz, and sand produced by the breaking-up of flint, does not appear to be generally understood. Chemical analysis gives no assistance; and when examined microscopically by ordinary light, no difference can be detected.

Polarised light, however, differentiates these two substances in such a decided way, that where they alone are concerned, no doubt can remain for an instant as to whether a grain of sand consists of one or the other. The quartz, as of course everybody knows, is resplendent with prismatic colours, while the flint shows a cold steel-grey surface covered with a peculiar marking, which I am obliged to call a species of reticulation for want of a term more exactly descriptive. This marking I consider to be indicative of something in the structure of the organism replaced by the flint. When once seen it is easily recognised. Some species of chert, that from the Portlandian beds for instance, show the same marking as flint.

I may also add that polarised light shows chalcedony to be, like quartz, a crystalline instead of a non-crystalline substance, as usually taught. It bears the same relation to quartz crystals and massive quartz as fibrous gypsum does to selenite and common gypsum. M. HAWKINS JOHNSON

Polarised Light

WE have all noticed that when the sun shines directly through a window hung with figured muslin curtains, the reflection of the pattern of the curtains in the window interferes with the prospect.

When this reflected image is viewed through a Nicol's prism it disappears when the prism is rotated, leaving the prospect unobstructed; the experiment is very interesting, and can be performed by any one who has a polariscope attached to a microscope, and it is only necessary to observe that the image is viewed at the proper angle. The effect will possibly be best when the sun's rays make an angle with the curtains and the glass nearly coinciding with the polarising angle. (In my case the angle was 36° 52′.)

Tyndall has mentioned a case in which the haze obstructing the view of a mountain-top was rendered transparent by the Nicol.

The readers of NATURE have probably observed how completely the leaves of the ivy polarise light; viewed through the Nicol and a pink selenite, the plant appears covered with blossom.

R. S. CULLEY

CHOLERA AND SUN-SPOTS

ON Friday evening, the 26th ult. Mr. B. G. Jenkins, of the Inner Temple, read before the Historical Society a remarkable paper on Cholera, founded on a communication to the Russian Imperial Academy of Sciences, and now under the consideration of the Medical Council of the Minister of the Interior. The author of the paper maintained that no true advance could be made in any science founded on experience, and looking to facts for its development, until the history of that science had been recorded and correctly interpreted; and that it was, because we have been looking at the facts of cholera, which have been accumulating for half a century, as facts without attempting to show, or rather without succeeding in showing, in what relation they stand to each other, that we are really no wiser than we were forty years ago.

He held that, instead of one "home" of the cholera in the delta of the Ganges, there are seven, all situated on or near the Tropic of Cancer, equally distant from each other, of which the most important is that at the mouth of the Ganges; the others are to the east of China, to the north of Mecca, on the west coast of Africa, to the north of the West India Islands, to the west of Lower California, and among the Sandwich Islands; that a reference to the map would show that the recorded appearances of cholera over the globe may be satisfactorily explained by supposing seven atmospheric streams, each 1,400 miles in breadth, to proceed from these foci in a north-westerly direction; and that at some periods, as 1833, 1850, and 1866, nearly all the streams were in activity.

Having pointed out the course of these streams on a map especially prepared, and shown how the disease moved within the limits of each, in both the north-west course and its south-east extension across the Equator, the author, in tracing in detail the course of the cholera in India during 1817 and 1818, called attention to a remarkable law which manifested itself, a law which he held was generally applicable wherever cholera appeared.

Although the course of cholera during 1817 was not very clear, still it is evident that it was north-west and south-west. The lull in virulence and advance which occurred in December 1817 continued to March 1818, when cholera broke out again just where it had ceased the previous December. He drew attention to a very recent similar instance: the cholera last year halted on the western border of Russia, and about a fortnight ago broke out in Poland, which augurs ill for the North of England this year. The remarkable law which the author pointed out was that in 1818 the cholera advanced simultaneously in two directions, north-west and south-west, in such a manner that all the places attacked at any given time by its north-west advance were situated at right angles to all the places attacked at the same time by its south-west advance. This double advance is made evident by cutting a piece of paper square, placing a corner upon the map at Calcutta, and moving it across India in a direct line to Surat. In 1819 the cholera crossed the Arabian Sea to Muscat, and passed simultaneously through Persia, and up to 1823 advanced as far as Asia Minor and the Caspian, and then died out. In 1823 a fresh outbreak occurred in India; this steadily proceeded to the north-west, and halted in the west provinces of Russia in 1830, and the next year broke out in full force in the same locality, thus presenting a parallel to 1871-2, and went as far as Britain. By referring to the map it will be seen that all places attacked by this stream of cholera in 1831 lie within the boundaries represented by two lines, one drawn from the southern point of India to the north of England, and the other from the Ganges through Orenburg to Archangel. The author having described with great minuteness the rise and progress of the other six streams, bringing the subject down to the present day, stated that Europe was liable to attacks from two great sources, India and Arabia: Russia and Northern and part of Central Europe coming under the influence of the Indian stream; Southern and Western and part of Central Europe under the influence of the Arabian; and that the Continent would certainly be attacked by both this year. The curious cases of ships at sea being suddenly attacked by cholera, and, again, the instances of ships sailing along the coast of India being struck by the disease when at the same place, he explained on the supposition that they had been sailing within the limits of the cholera streams; for when they got outside the limits the disease suddenly ceased. He called attention to a fact worthy of mention, that all the places recorded by Dr. Gavin Milroy as unaffected hitherto by cholera lie outside these streams, or in their possible, but not actual, extension.

Having stated that he was prepared to give, in another paper on the origin of the disease which he was preparing, an ample explanation of some well-known points about cholera; such as its partial connection with the east wind, its following the course of large rivers, its greater prevalence on tertiary strata, alluvial tracts, and the deltas of rivers, and its comparative rarity on secondary and primary strata, the author proceeded: "It was not my intention at the present time to enter into the question of the origin of the disease; but having read a few days ago that Dr. Buchanan in this very hall congratulated the meeting on being able to number among the things of the past the time when the propagation of cholera was supposed to be due to all manner of cosmic and atmospheric influences, and on having 'reached a solid basis of fact and knowledge upon which further observation might be built with security,' I am tempted to declare that I for one maintain that this despised theory, which Dr. Buchanan fancies is buried and put out of sight, is the correct one. I maintain that cosmic influence lies at the origin of cholera—that cholera is intimately connected with auroral displays and with solar disturbances. I believe that I am able to show that a remarkable connection exists between the maxima and the minima of cholera epidemics and of solar spots; and in directing your attention to this map, on which I have represented graphically the amount of cholera and the number of sun-spots for the last fifty years, I wish to show that there is here also 'a solid basis of fact and knowledge upon which further observation might be built with security.' You are all probably aware that the great astronomer Schwabe discovered that the sun-spots have what is called a ten-year period; that is, there is a minimum of spots every ten years. It was also discovered that the diurnal variation in the amount of declination of the magnetic needle has a ten-year period. The same was proved in regard to earth currents, and also auroræ. The maxima and minima of the four were found to be contemporaneous. This was a great result; but Professor Wolf, on tabulating all the sun-spots from the year 1611, discovered that the period was not ten years, but 11·11 years. This period is now the accepted one for the sun-spots, and it has been established for the magnetic declination, and by Wolf for the auroræ. Now, it is a curious fact that the last year of every century, as 1800, has a minimum of sun-spots, so that the minima are 1800, 1811·11, 1822·22, 1833·33, &c. The maxima do not lie midway between the minima, but anticipate it by falling on the year 4·77 after a minimum; for example, 1800 was a minimum year, then 1804·77 was a maximum year. Now, cholera epidemics have, I believe, a period equal to a period and a half of sun-spots. Reckoning then from 1800, we get as a period and a half the date 1816·66, which was shortly before the great Indian outbreak; another period and a half gives 1833·33, a year in which there was a maximum of cholera; another, 1849·99, that is, 1850, a year having a maximum of cholera; another, 1866·66, a year having a maximum of cholera; another, 1883·33, as the year in which there will be a cholera maximum. It follows from what has been already said that 1783·33 would be a year in which cholera was at a maximum. Now it is a fact that in April 1783 there was a great outbreak of the disease at Hurdwar.

"I would call attention to the parallelism of increase and decrease of these curves. I am not, however, prepared to say that sun-spots originate cholera; for they may both be the effects of some other cause, which may indeed be the action of the other planets upon the earth and upon the sun. If that be the case—and I see no reason why it should not—we may then have an explanation of the minor periods and of the large period of 56 years, which Wolf believes he has detected, and also of the minor periods observed in cholera-epidemics.

"My own opinion, derived from an investigation of the subject, is that each planet, in coming to and in going from perihelion—more especially about the time of the equinoxes—produces a violent action upon the sun, and has a violent sympathetic action produced within itself—internally manifested by earthquakes, and externally by auroral displays and volcanic eruptions, such as that of Vesuvius at the present moment; in fact, just such an action as develops the tail of a comet when it is coming to and going from perihelion; and when two or more planets happen to be coming to or going from perihelion at the same time, and are in, or nearly in, the same line with the sun—being of course nearly in the same plane—the combined violent action produces a maximum of sun-spots, and in connection with it a maximum of cholera on the earth. The number of deaths from cholera in any year—for example, the deaths in Calcutta during the six years 1865-70—increased as the earth passed from perihelion, especially after March 21, came to a minimum when it was in aphelion, and increased again when it passed to perihelion, and notably after equinoctial day; thus affording a fair test of my theory."

ON THE DEPTHS OF WATER IN WHICH WAVES BREAK

OBSERVATIONS MADE AT SCARBOROUGH IN 1870

As the force which different sea-works have to resist varies with the height of the waves that reach the coast line, any data which will enable the marine engineer to predict this height when designing such works must obviously be of importance. In the *Edinburgh Philosophical Journal* for July 1852, I stated, as the result of experiments made in 1850 on a small fresh-water loch, and afterwards on larger sheets of water, that the height of the waves increased most nearly in the "*ratio of the square root of their distances from the windward shore*," or, in other words, *the crest of the wave as it increases in height describes a parabolic curve*. So that, if h = height of wave, d = distance, and a is a coefficient varying with the strength of the wind, $h = a\sqrt{d}$. For most practical purposes of the engineer, the coefficient a may for heavy gales be taken at one and a half; so that the formula becomes—

$$h = 1{\cdot}5\sqrt{d},$$

where h represents the height of the wave in feet, and d = length of exposure in miles.* As elsewhere stated,† this formula becomes for short distances—say for under ten miles—

$$h = 1{\cdot}5\sqrt{d} + (2{\cdot}5 - \sqrt[4]{d}).$$

The height of the wave, however, which reaches any particular work, is not necessarily that which is due to the line of exposure; for the shallowing of the water near the shore may cause the heaviest waves to break, either partially or wholly, before they reach the work. Mr. Leslie found that at Arbroath Harbour the works were not so severely tried by the very heaviest class of waves as by others of lesser size, which were not *tripped up* by the outlying rocks. The same effect has also been observed at the river Aln, where the smaller waves occasion a greater "range" in the harbour than the larger ones which break in passing over the bar, and are thus reduced in height. The larger waves are not, then, always so destructive as the smaller. It becomes, therefore, a question of some moment to determine the maximum height of wave that is possible in a given depth of water.

Mr. Scott Russell, whose contributions to what may be

* Mr. Hawkesley, in the "Proceedings of the Institute of Civil Engineers," gives a formula which is satisfactory so far as it corroborates the law of increase which I had stated in the *Edinburgh Philosophical Journal* in 1852; but he employs a coefficient which gives much greater results than my experience warrants.

† "The Design and Construction of Harbours," by Thomas Stevenson, F.R.S.E. (Edinburgh, 1864: p. 22).

called the marine branch of hydrodynamics are of such great value, has stated that "he has never noticed a wave so much as 10ft. high in 10ft. water, nor so much as 20ft. high in 20ft. water, nor 30ft. high in five fathoms water; but he has seen waves approach very nearly to those limits." Mr. Russell has not stated whether the depths of water referred to are those below the trough of the sea or below the still-water level. In my book on "Harbours" I gave three observations on short waves from 2ft. 6in. to 3ft. high, which corroborated Mr. Russell's statement, supposing him to refer to the depth below the hollow. But since that time I had an opportunity, during a N.E. swell in July 1870, of observing the depths in which waves of a larger class broke at the Promenade Pier at Scarborough, where the heights could be measured with very considerable accuracy on the iron piles and open sloping slip or grating at the seaward end of the pier; and the following are the results:—

Heights of waves from hollow to crest.

′	″
5	6
5	0
5	0
5	6
5	3 = mean height.

The mean depth of water below the trough was 10ft. 3in.

Heights of the highest waves from hollow to crest.

′	″
6	0
6	0
8	0
6	0
6	0
6	6 = mean height of highest waves.

The mean depth of water below the trough was 13ft. 8½in. So that in both cases those waves did not follow Mr. Russell's law, but *broke when the depths below their troughs were about twice their own height.*

It must not be supposed, as is generally believed, that the height of the crest above the mean level of the sea is equal to the depression of the trough below that level; for Prof. Rankine has lately shown that this is not the case. When L = length of wave, H = height from trough to crest.

$$\text{Crest } above \text{ still water} = \frac{H}{2} + \cdot 7854 \frac{H^2}{L}.$$

$$\text{Trough } below \text{ still water} = \frac{H}{2} - \cdot 7854 \frac{H^2}{L}.$$

These formulæ, he states, are exact only for water of considerable depth as compared with the wave's length.

Edinburgh THOMAS STEVENSON

CYCLONES IN THE INDIAN OCEAN

SEVERAL cyclones have passed Mauritius since the latter part of January. From the 24th to the 30th of that month the barometer at the Observatory fell from 29·888 to 29·708 inches, with the wind squally from E. At 10 A.M. on the 30th it was intimated to the newspapers that there were "indications of a hurricane approaching the island;" but at 2 P.M., the wind having in the interval veered to N. of E., it was announced that there was "little danger."

This storm was encountered by the schooner *Emily*, on her passage from Tamatave, from Jan. 29 to Feb. 1. At the commencement of the gale, she was in 19° 31′ S., and 53° 30′ E. The wind veered from N.E. to E., S.E., S., S.W., W., and N.W., with a "tremendous sea and torrents of rain," and the lowest reading of the barometer on board was 29·00 inches. The vessel escaped with the loss of only a few sails.

The storm then curved to the S. and E., and was experienced by the barques *Gladiateur* and *Abbotsford* on Feb. 2 and 3, in 31° to 29° S., and 54° to 55° E. With the former vessel the wind veered from E. to N.E. and N., blowing at one time with great violence. The barometer at 8 A.M. on the 2nd was at 28·80, and the wind from E.N.E. The *Abbotsford* had the wind from the same direction, and her barometer was at 28·40 at 5 A.M. on the 2nd. Both vessels had a "tremendous sea and torrents of rain," and they lost sails and bulwarks.

On Feb. 5 the barometer at Mauritius, after rising to 29·790, again began to fall, and on the 7th was at 29·606. The wind was squally from S.E., and it veered to S. by W., from which point there was a gentle breeze at 9.30 P.M. on the 7th, with fine clear weather.

At 10 A.M. on the 7th it was announced that "the weather of the last two or three days indicated the passage of another storm, which then broke between E.N.E. and E.;" and at 10 A.M. on the following day that "the storm had curved to the S. and S.E."

This storm was encountered by the barque *Elizabeth*, from Melbourne to Mauritius, on the 7th and 8th, in 20° 16′ S., and 68° E. The wind was strongest from E.N.E. to N.N.E., and the lowest barometer was 29·20. There were "torrents of rain." By standing back to the E. the *Elizabeth* avoided all danger.

On Sunday, Feb. 11, the barometer at the Observatory, after rising to 29·870, again began to fall, with the wind squally from S.E., and the weather fine. During the 12th it fell ·060 inch, and ·090 inch more during the 13th, with the wind still squally from the same quarter. At 10 A.M. on the 14th the following notice was sent to the newspapers:—"A hurricane since the 11th. It now bears about E.N.E. of us. There are some signs that it will pass to the E. and S. of the island, but there is danger." The barometer still falling, and the wind increasing to strong breezes from S. by E. to S.S.E, at 3 P.M. a telegram was sent to Port Louis (6 miles off), stating that "the centre of the hurricane was about 350 miles to the E.N.E., and approaching the island," and soon afterwards storm signals were hoisted at the railway stations. The barometer at 3 P.M. stood at 29·612, and the wind, which was then S. by E., was blowing with an estimated force of 2·5lbs. on the square foot.

At 9 A.M. on the 15th the barometer was at 29·478, with a strong gale from S.E., and it was estimated and announced that the "centre of the storm bore about N.N.E. 150 to 200 miles, and that it was still approaching the island." At 3 P.M. the wind being from E.S.E. to E. by S. in increasing gales, and the barometer at 29·382, it was telegraphed to Port Louis that "the centre was about 150 miles to N. by E., and that it would probably pass, with an increase of wind, to N.W. and W. of the island, without doing much damage."

During the night the wind increased considerably from E.S.E. to E. by S., and the barometer attained its lowest reading (29·328) at 1 A.M. on the 16th; but the mercury was oscillating, being at 2 A.M. at 29·356, and at 3 A.M. 29·330; and the time of the greatest depression of the mercury, as shown by the barograph (at the Magnetic Observatory, three miles off) was 2.40 A.M. At 9 A.M. the barometer was at 29·440, with the wind at E. to E. by N., and it was announced that "the centre bore N.N.W., and that there was no danger."

The barometer then continued to rise, until, at noon on the 18th, it was at 29·882, with a moderate breeze from N.E.

It is worthy of remark that the wind never went beyond N.N.E., but gradually backed to East.

This storm was more or less encountered at sea by the *Harpesia*, *Gryfe*, *Oleander*, *St. Germaine*, *Misser*, *S. S*, *Danube*, *Staffordshire*, *William Fairbairn*, *Pendragon*, *Odalisk*, and *Paolo Revello*, some of which suffered severely.

At 5 A.M. on the 15th, the *Staffordshire*, in about 18° 30′ S. and 61° E., was thrown on her beam ends, and in great danger of foundering. The *William Fairbairn*, a fine iron vessel of 1,293 tons, lost all her masts and sails, and had her decks almost completely swept. On the 13th, in 19° 2′ S., and 64° 40′ E., she had a strong gale from S.E., which increased to a hurricane. About 7 P.M. her barometer was at 28·70, and early on the 14th the wind shifted from S.E. to N.W. The *Paolo Revello*, on the 14th, in 18° 8′ S. and 61° 54′ E., was completely gutted. The captain's papers and log-book, cabin furniture, &c., together with the chief officer and nine men, were washed overboard.

From the logs hitherto received it appears that the storm was formed between the S.E. trade-winds, and the N.W monsoon from the 7th to the 9th. On the 10th the centre was in 13° 10′ S. and 78° 30′ E.; on the 12th in 15° 6′ S., and 71° 34′ E.; on the 14th in 17° 15′ S., and 63° 28′ E.; on the 16th in 20° 7′ S., and 55° 50′ E.; and on the 18th in 22° 15′ S. and 51° 50′ E. During the first six days it travelled on a W.S.W. course, and then curved a little towards the south. It passed about 165 miles north of Rodrigues at noon on the 14th, about 65 miles north of Mauritius early on the 16th, and N.N.W., &c., of Reunion from noon on the 16th to noon on the 17th. Its average rate of progression was nine miles an hour, and the area over which the wind blew from strong breezes to hurricane violence was about 800 miles.

The fact that in this, as in other storms, the wind at Mauritius did not veer more than twelve points, seems to be explained by the incurving of the air towards the centre.

On the evening of the 15th, or morning of the 16th, seventeen vessels put to sea from the roadsteads of Reunion, and their fate is not yet known. If they held to the N.W., with the wind from S.E., they probably got into the heart of the storm.

CHARLES MELDRUM

Mauritius, March 8

P.S.—The aurora seen here on the night of the 4th to 5th February, was also seen at sea by several vessels. Here are extracts from their logs :—

Olive Branch in 27° 47′ S. and 59° 48′ E.—"At 10 P.M. the sky became very red and fiery—southern lights."

Abbotsford in 30° 9′ S. and 56° 10′ E.—"Dull atmosphere. Aurora australis reflecting brightly in the south, giving light over all the ship. Clouds tinged with deep red."

Elizabeth in 20° 33′ S. and 78° 3′ E.—"At 10 P.M. Aurora australis unusually bright."

Gladiateur in 30° 32′ S. and 57° 28′ E.—"At 8 P.M. a red and yellow and strange looking sky. Midnight, sky the same."

Pendragon in 13° 43′ S. and 84° 13′ E.—"At midnight very suspicious-looking weather to the S., the sky being quite red."

William Fairbairn in 32° 57′ S. and 60° 2′ E.—"At 10 P.M. looking ugly, and meteorological signs of a hurricane. Midnight same, and up till 3 A.M. when it cleared off."

Caton in 31° 31′ S. and 108° 10′ E.—"Midnight, red sky, like fire to E.S.E."

Oleander in 38° 26′ S. and 31° 53′ E.—"From 7.30 to 11.30 P.M. the sky was illuminated with a very brilliant Aurora australis."

There is little doubt that the suspicious-looking weather to the S., seen by the *Pendragon* in about 14° S., was the aurora. Captain McKenzie of the *W. Fairbairn* reports that his standard compass was affected to the extent of ¾ of a point, and his other compass to the extent of two to three points. C. M.

PHYSICAL SCIENCE IN GLASGOW UNIVERSITY

THE Physical Laboratory of Glasgow University, which till quite lately was the only one in this country, dates from the year 1852. It was with difficulty that room could be found for a laboratory of any kind in the old building; but in the new building, of which this is the second year of habitation, considerable space has been set apart for Experimental Natural Philosophy.

At present six rooms belong to the department, exclusive of the Professor's private sitting-room and the store-rooms, and on the completion of the tower, which is not yet finished, additional rooms will be devoted to it. The whole suite of rooms is arranged so as to be in direct communication with those of the professors of mathematics, engineering, and astronomy.

The chief lecture-room is 42ft. long by 35ft. broad, its side windows look nearly north and south, and over the lecture table there is a glass-covered turret, or louvre, the top of which is 40ft. from the floor. The windows of the room are completely darkened with the greatest ease by means of double curtains of blue baize, an inner and an outer curtain for each window, and these can be unfurled and furled at a moment's notice; two baize screens, one below the other, are drawn across the base of the louvre. The room is ventilated, as are all the rooms in the new University building, on Mr. Phipson's plan. Pure air is drawn down a shaft in the tower by fanners, which are worked by a small steam engine. The air is passed through a dry chamber, containing hot water pipes, and is then driven mixed with any quantity of fresh cold air that may be required, into the class-room. It enters at the top of the room, and the used air is drawn off through passages below the floor.

Benches are arranged for about 150 students. They are not on a level, but rise at an angle of 25°, and beneath them there is a large convenient space, with shelves for 50 or more cells of Daniell's battery, which I shall describe immediately.

Of the other five rooms one is an additional lecture and experiment room, one is the general laboratory, one is the principal apparatus room and museum, and the remaining two are used for storing apparatus and for occasional experimenting. The laboratory is on the ground floor, and is below the lecture-room, which is on the second story. It is a room 52½ft. long by 34ft. broad. It has six windows, three looking north and three looking south, and these can be darkened like those in the lecture-room by means of drop curtains of baize. Three quarters of the floor is wood, the remainder concrete, covered with Portland cement; but in order to get perfectly steady tables, piers of masonry, built on the foundation, rise through the floor, and on them the feet of the tables rest. The flooring does not touch the piers at all, and thus, however much the floor may shake, the table remains comparatively steady. This arrangement gives far greater steadiness than a complete stone floor. Besides these piers there are two somewhat larger stone constructions, which are also unconnected with the flooring; one of these is intended for a large steady table; and on the other there is a massive stone erection (Fig. 1), on which is to hang a pendulum for a clock, or for experiments on the force of gravity. It is intended that the point of suspension of the pendulum shall be perfectly free from vibration.

Some of the tables are ordinary working tables. On others, instruments such as the electrometer and electrodynamometer are set. Below the table there are frames for supporting 500 cells of a constant Daniell's battery, which were in use in the old college, and a great part of which are now re-charged.

In one corner of the room there is a wooden enclosure, which is fitted up as a small chemical bench. The ordinary reagents and apparatus for chemical testing are thus at hand.

There are large gas holders, each holding eighteen cubic feet of gas, in the laboratory. The construction of the gas-holders is the same in principle as that used in ordinary gas works. Each is, in fact, a large copper bell, with its mouth dipped under water in a deep tank. All the stop-cocks connected with the gas-holders are kept constantly enclosed in vessels full of water, in order to prevent leakage. The holders are filled at the beginning of the session, one with oxygen and the other with hydrogen, and the lime light is thus always ready.

With this brief account of the general arrangement of the premises, I shall now describe more particularly some of the apparatus and conveniences of the lecture-room and laboratory, and some of the experimental investigations going on at present.

The lecture-table in the lecture-room is 26ft. long by 2¾ft. It is not straight, but made of three pieces, so as to be concave on the lecturer's side. A portion of the top of the table is removable; and when it is taken away a large trough suited for showing waves in water, and for other hydrodynamic experiments, is exhibited. The trough is as long as the table, and is 14in. broad and 12in. deep. It opens out at one end

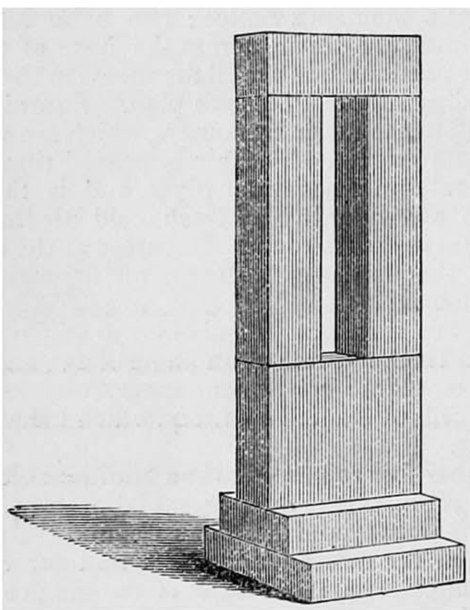


FIG. 1

into a tank 26in. broad and 20in. deep. The lecture-table is, of course, furnished with the usual supply of coal, gas, and water; and besides pipes, which give hot water and steam, are led to it. These pipes come from the boilers that heat the air with which the University buildings are warmed and ventilated. Pipes are also led to the table from the oxygen and hydrogen gas holders in the lower laboratory, so that the oxyhydrogen light is always at command at a moment's notice; and it is found a great convenience to have it so. It is used very frequently, and enables us to show to a large class many experiments which we could not attempt without it—experiments, for instance, with the reflecting galvanometer and electrometer. The preparation for such experiments generally requires much time and trouble; but with the permanent gas-holders filled once for all at the beginning of the session and always ready, the oxyhydrogen light gives less trouble than an ordinary oil lamp.

A powerful battery, which I shall have to describe immediately, is always ready. Very thick electrodes, consisting of nine ply of No. 16 copper wire of high conductivity, plaited together, pass from binding screws on the lecture-table to the battery below the lecture-room seats, and thence down to the lower laboratory.

For instruments that require a very steady support there are two pillars, one at each end of the lecture-room table. These are unconnected with the flooring. They pass through it without touching the boards, and rest on the stone arches that cover a gateway beneath.

On each side of the lecture-room there is a clock. One of them is governed by electricity on Jones's principle; the other is an electric clock by Bain, and has a current from a single cell for its motive. The former is an ordinary eight-day clock, and is regulated in the following way:—The bob of the pendulum is a hollow coil of insulated wire. The plane of the coil is perpendicular to that of the motion of the pendulum. The ends of the coil are carried up the pendulum rod, and are connected with telegraph wires which proceed from the Observatory of Glasgow University. Fig. 2 gives a front view of the pendum, and shows the coil and a pair of permanent magnets pointing towards the coil. When the pendulum swings the hollow coil passes over the end of the magnet at each side. Fig. 3 shows the suspension of the pendulum, which consists of two flat springs, to which the wires coming up the pendulum rod are joined. The springs are attached to insulated brass pieces, to which are connected, by means of binding screws, the wires from the Observatory. There is a clock in the Observatory which is constantly kept right, and by means of a make-and-break arrangement connected with its pendulum, a galvanic cur-

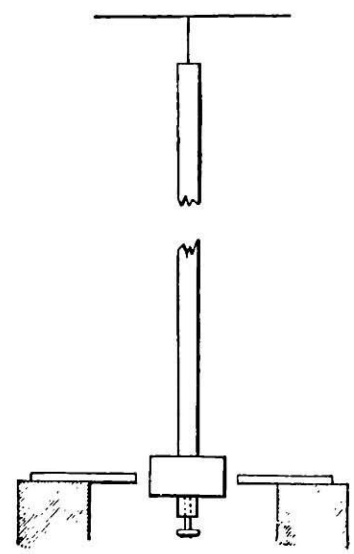


FIG. 2

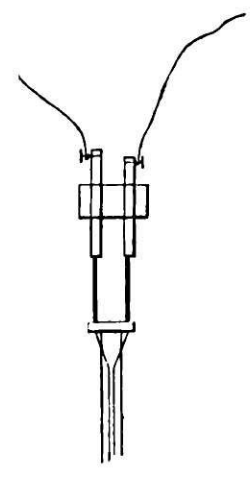


FIG. 3

rent is sent once in each second through the wire that proceeds from the Observatory, and thus through the coil at the extremity of the pendulum of the clock that is to be controlled. The coil is thus once in each second converted into a temporary magnet, and is attracted and repelled by the permanent magnets between which it swings. It will be readily understood that with this arrangement a clock that is going slightly too slow may be accelerated a little, and a clock that is going slightly too fast may be retarded a little, at each passage of the current. To be able to set the controlled clock to agree with the Observatory clock, it is necessary to have some way of distinguishing one second from another. This is done by means of a galvanoscope or indicator, which is included in the circuit, and which beats seconds with the currents. The instrument is placed close to the clock in a place convenient for comparison of it and the seconds hand of the clock. It is arranged that there shall be no beat on the last second of each minute; and that in the last minute of each hour there shall be an interval of twenty seconds without any current. Thus the ends of the minutes and the ends of the hours are distinguished.

Of mechanical apparatus almost daily employed for lecture illustrations may be mentioned various kinds of vibrators, weighted spiral springs, a Coulomb's torsion vibrator, a cycloidal and a common pendulum arranged for comparison, a friction brake, &c., &c. Over the lecture-table there is suspended from the top of the louvre already mentioned a pendulum, which is intended to show the rotation of the earth. The length of it is 38 ft.; and it thus executes one complete vibration in rather less than seven seconds. In showing the rotation of the earth by Foucault's method, everything depends on perfect symmetry in the suspension of the pendulum. The suspension used here is quite new, and, I think, will prove satisfactory. I hope to take an opportunity of describing it hereafter, when I can make a statement as to results obtained.

I believe that every one who has ever had to work in a laboratory with a large battery has felt how much a powerful and constant cleanly and easily managed battery is wanted. A dozen batteries have been invented, and some of them patented within the last two or three years. Most of them are only fit for such purposes as ringing an electric bell for an instant, and even at such work as that they do not last long, and not one of them is even tolerably constant, though constancy is pretended for almost all. What is wanted is a battery that will remain constant for six months or a year without more attention than that of occasionally wiping the outsides of the cells, and replenishing them with some salt or acid and with water; and which is powerful enough for an electric light or for any other class experiment. Freedom from acid fumes is also in most laboratories an essential. A great many experiments have been made here with the view of getting such a battery as I have described, and at last, as we hope, with some success.

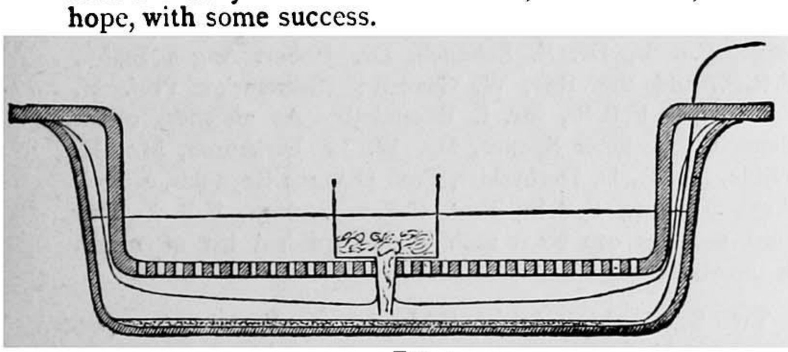


FIG. 4

Since the invention of Grove's battery, that and Bunsen's modification of it have been almost exclusively used for the electric light. These, as far as high electromotive force and smallness of resistance are concerned, are preferable to any other; but there are great objections to the use of them in the necessity for discharging them frequently, and in the emission of acid fumes, which cannot but be injurious to the person who discharges the battery, and which are very destructive to apparatus unless the battery be kept in a special chamber. The battery which we are employing in Glasgow, and which gives great promise of being really successful, is a modification of Daniell's battery.

Sir William Thomson described (Proc. R. S., Jan. 1871, quoted in NATURE of Feb. 2, 1871) a gravitation battery, in which advantage is taken of the fact that water saturated with both sulphate of zinc and sulphate of copper is denser than either saturated solution of sulphate of zinc alone or sulphate of copper alone. A horizontal copper plate being put at the bottom of the cell and a plate of zinc near the top, the cell is charged with saturated solution of sulphate of zinc, and crystals of sulphate of copper are placed in a funnel, whose delivering-tube passes down to the bottom of the cell. The superior density of the solution containing sulphate of copper in addition to the sulphate of zinc, is that which keeps the sulphate of copper from surrounding the zinc plate and attacking it. This arrangement, if the sulphate of copper travelled towards the zinc solely by diffusion, would have great advantages over any in which the zinc and copper plates are placed vertically, and a porous separator is used.

It was thought that the form of cell described then would turn out admirably, and it is excellent in many ways; but it was found that a constant evolution of hydrogen takes place at the copper plate, bubbles rising perpetually from it. These cause so much stirring up of the solutions that sulphate of copper is carried rapidly up to the zinc plate, and both eat the zinc away, and it is itself wasted in depositing copper on the zinc plate. The reason of this bubbling appears to be that particles drop from the zinc on to the copper plate, and, forming small circuits there, send up hydrogen bubbles through the liquid. We have now done away with the difficulty in the following way, and we have got a cell which, so far as we have been able to test it, promises to be in all respects satisfactory. The under surface of the zinc is now covered with a sheet of parchment paper (known as manilla) the edges of which are brought up round the zinc, so that it is enclosed in a porous cell of this material. The paper, while it does not add sensibly to the resistance of the cell, acts most beneficially by hindering the particles which drop off the zinc from falling on to the copper plate; and if there are any bubbles rising from below, it prevents them from bringing sulphate of copper up to the zinc plate.

We are now employing two kinds of cells, and have forty of each kind in action. The first is very similar to that described by Sir W Thomson in the paper already referred to. The cell is of glass (Fig. 4); and this is an advantage, as the condition of the solutions and metals which it contains may be seen at any time. It is a circular pan* with a flat bottom. The diameter is 21 inches. A disc of thin sheet copper is laid on the bottom; and a thick copper wire covered

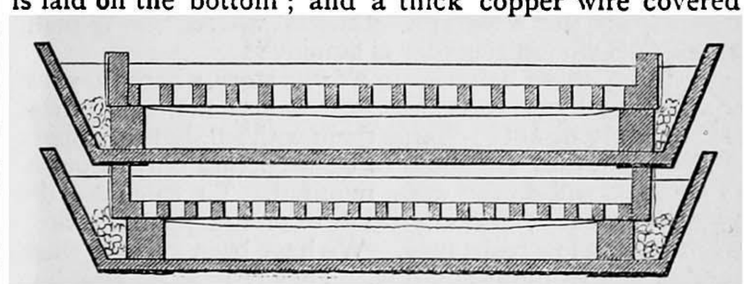


FIG. 5

with gutta percha is soldered to the copper disc and rises to the top of the cell as an electrode. In the upper part of the cell is a heavy mass of zinc, cast into the form of a circular gridiron, with three ears or projections which rest on the edges of the glass. The gridiron shape is adopted in order to permit the hydrogen, which we find constantly being liberated, to escape. The distance between the zinc and copper plates is about 2½ in. A large sheet of parchment paper covers the under side of the zinc, and the corners and edges of the paper are brought up round the vertical sides of the zinc so as to form a kind of bag round it. The parchment paper is thus a separator between the mass of liquid in the cell and that immediately surrounding the zinc. There is a circular hole in the middle of the zinc, and the tube of a glass or earthenware funnel passes through this and through a hole in the parchment paper, the edges of which are tied round the tube, down to the bottom of the cell. The cell is then filled up with saturated solution of sulphate of zinc till the level of the liquid is higher than that of the top of the zinc; and on the top of this a layer of pure water two or three inches deep is poured carefully, so as to avoid mixing. The pure water forms an atmosphere into which the sulphate of zinc formed during the action of the battery may diffuse, and thus crystallisation is avoided. To set the cell in action crystals of sulphate of copper are put into the funnel just described. The dense solution

* The pans that we are using are, I believe, made by glass-blowers for milk pans. They are inexpensive, and answer excellently. To make the bottom horizontal we cover it with sand moistened with saturated solution of sulphate of zinc, and carefully level it by comparison with a little of the liquid lying on the top. It is essential to have it level if we wish to use up all the charge of sulphate of copper, as described in the text, to the best advantage.

flows down over the copper plate at the bottom, and in less than five minutes the cell is in full work.

We have at present forty cells such as I have just described. The average resistance of one cell is 0·19 of an Ohm. The electro-motive force of a Daniell's cell is 1·07 Volts.

The second form of cell is of the following construction. A shallow wooden tray, square, and with slightly slanting sides, is lined with sheet lead; and this, after being electrotyped with copper, forms both the containing vessel for the liquids and the copper plate of the cell. Copper trays were used at first, but they were soon eaten through by the solution. The lead is not attacked at all. The length of a side of the lead tray is 21in., and its depth is 3¾in. In each corner is set a small block of wood 1½in. high. The zinc plate, which is like a square grid-iron, rests at its corners on these blocks. The zinc has parchment paper tied round its lower surface and sides. The cell is filled up with saturated solution of sulphate of zinc, and crystals of sulphate of copper are dropped in when required round the edges outside the parchment paper. For connecting these cells together in series, the lead lining is carried over the wooden tray at the corners and down the outside to the under surface of the bottom of it. Here it is soldered to a small square of thick sheet tin. The cells are piled up one on the top of the other, the tin plates of the second cell resting on the zinc of the first, and so on. The tin connections—a suggestion of Mr. Varley—are most excellent. Two of these cells are shown in section Fig. 5. The resistance of each of these cells is on an average 0·19 of an Ohm. They are now used at all the telegraph stations where Sir William Thomson's siphon recorder is employed.

In using these batteries in a laboratory where they are not perpetually at work, the best way of managing them may possibly be not to charge them with sulphate of copper except when they are about to be used, and only to put in as much as will do the work required. To calculate the quantity is easy; and any small excess might be worked off through a low resistance. We have been keeping them at work almost night and day. They require no attention except to be occasionally supplied with sulphate of copper crystals, and to have the sulphate of zinc that creeps up over their edges wiped away with a cloth.

At present our battery is tested very frequently, generally once in four or five days. The electromotive force and the internal resistance of each cell is determined. We have now had the greater number of the eighty cells in action for three months, and some of them for five or six months. During all that time they have been most satisfactory, the electromotive force of them having remained perfectly constant.

We test them by means of the reflecting electrometer, or the tangent galvanometer.

J. T. BOTTOMLEY

(To be continued.)

NOTES

AFTER we went to press last week, a most cheering telegram was received in this country respecting the fate of Dr. Livingstone, as follows:—' Aden, May 1, 1872.—The *Abydos* has returned from Zanzibar. She brings news that Dr. Livingstone is safe with Stanley. The news is brought by natives." It may fairly be hoped that still more authentic intelligence will shortly be received respecting the fate of the great traveller, with respect to whom such anxiety has been manifested in this country. Another despatch speaks also of the destruction of a large portion of the town of Zanzibar by a terrible hurricane on April 15.

THE eruption of Vesuvius, respecting which we gave such details as were accessible last week, appears to be over. Whether any scientific results have been obtained by any observers besides Palmieri it is too early yet to know. We hope it may be so, and shall return to the subject as soon as the authentic accounts have been collated.

THE Annual Visitation of the Board of Visitors to Greenwich Observatory will take place on Saturday, June 1st.

THE President, Vice-President, and Council of the Pharmaceutical Society of Great Britain will hold a *conversazione* at the South Kensington Museum on Wednesday evening next, May 15.

AT a meeting of Convocation at Oxford last week, it was carried that in all the schools, except that of theology, examiners might be appointed who were not members of the University. The liberal change which had already been granted for the Natural Science School will do much to widen the general course of reading at that University, and to prevent the studies pursued there partaking too much of any narrow or special character.

MR. CHARLES TOMLINSON, F.R.S., lectures this evening at the London Institution, Finsbury Circus, on Solution and Supersaturation.

AT the Annual Meeting of the Literary and Philosophical Society of Manchester, held on the 30th ult., the following officers were elected for the ensuing year:—President, Mr. E. W. Binney, F.R.S., F.G.S.; Vice-Presidents, Dr. Jas. P. Joule, F.R.S., Dr. E. Schunck, Dr. Robert Angus Smith, F.R.S., and the Rev. W. Gaskell; Secretaries, Prof. H. E. Roscoe, F.R.S., Mr. J. Baxendell. As members of the Council, Mr. Peter Spence, Mr. W. L. Dickenson, Mr. H. Wilde, Mr. R. D. Derbyshire, Prof. Osborne Reynolds, Mr. W. Boyd Dawkins, F.R.S., Prof. Balfour Stewart, F.R.S. Few local societies can boast such a distinguished list of names as the above.

TWO Scholarships of the annual value of 30*l.* and 20*l.* respectively, tenable for two years, have been founded by the Governors of the Middlesex Hospital, for the encouragement of the study of medicine and surgery, in memory of the late Francis Broderip, a munificent benefactor to the hospital. These scholarships will be open to competition, at the end of each winter session, amongst the general students of the hospital who shall have completed their third year of study at the Medical College. The successful candidates will be required to attend and work at the hospital for a fourth year, during which period they will be eligible for the various resident appointments.

TWO Scholarships, of the annual value of 25*l.* and 20*l.* respectively, will be offered for competition at Middlesex Hospital at the commencement of the Winter Session 1872-73. Each scholarship is tenable for two years, provided the scholar conducts himself satisfactorily. These scholarships are open to all gentlemen who commence their medical studies in October 1872. Successful candidates will be required to become general students of the College. The examination will take place on September 27 and following days, and the result will be declared on October 5. The following are the subjects for examination:—Latin, Greek, French or German, Mathematics, Natural Philosophy, Chemistry, Botany, Zoology. Candidates will be examined in any three of the above subjects they may select; but only one Modern Language and two out of the last three subjects are permitted. An equal number of marks will be given to each subject, and candidates will be expected to attain a certain standard of proficiency in the subjects they select. Candidates must send in their names in writing, addressed to the Dean, at the Middlesex Hospital, stating the subjects which they elect for their examination, on or before September 24.

We referred recently to Tilghman's ingenious process for cutting hard substances by means of a jet of sand. The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the mechanic arts, to whom the process was referred for examination, report that they have seen the operation, and that the invention seems capable of extensive use in the arts. Some of the products of the invention appear to present new and valuable features. Glass ornamented by this process can only be compared with that etched by powerful acids, yet the entire absence of all undercutting, no matter how deeply the glass is cut, renders it superior. The great merit of the invention consists in its extended utility. By means of this sand-blast effects have been produced which would be hard to imitate by any other known mechanical process, and with an ease and precision truly remarkable. They consider the invention original and of the highest utility, and deem it worthy of any mark of approbation it may be thought fit to bestow upon its originator. They therefore recommend the bestowal on the inventor of the Elliott Cresson medal of the Franklin Institute, in accordance with the rules governing such award.

Prizes to the amount of 25*l.* are offered by the proprietors of the *Gardeners' Magazine* for dinner-table decorations in fruit and flowers, or flowers only, arranged for effect in artificial light. The competition is to take place in connection with the Royal Horticultural Society's Exhibition in Birmingham, in June.

Prof. Hull, head of the Geological Survey of Ireland, has in the press a work designed to render practical service to builders and architects by information about the varieties of stone and their respective advantages for building purposes. "In arranging the matter treated in this work," says Prof. Hull, "I have not followed any very definite order, but rather that which the subject seemed to indicate." Regretting the incorrect nomenclature which is employed in the architectural classification of natural building materials, and yet feeling that the adoption of the mineral basis of rocks as the principle of arrangement would render his book less useful for reference by architects, the author has followed the plan drawn out on his fourth page. "Commencing with the noblest of all rocks, granite, I have been naturally led onwards to the allied rocks, such as syenite, porphyry, and from those to other plutonic or volcanic rocks. After these the metamorphic serpentines and marbles form a transition series through the simpler and rarer ornamental stones into those adapted for building, and of aqueous formation." The work will be published by Messrs. Macmillan and Co.

Our readers will be glad to learn that Dr. Bastian's "Beginnings of Life" will be published shortly after Whitsuntide. This book will be a complete exposition of those views of its author upon vital phenomena, and the conditions of their appearances, which have already excited so much interest and discussion.

The Rugby Council for Promoting the Education of Women has just published a very useful Calendar of women holding University certificates and engaged in teaching. It contains also all the needful information for those intending to try for the examinations for women and girls conducted by the Universities of Oxford, Cambridge, London, Dublin, Edinburgh, Durham, and the Queen's University for Ireland, and will thus be of essential aid, not only to these, but also to those who are seeking the services of women who have shown themselves capable of obtaining the highest educational honours as yet open to them. It may be obtained of Mrs. F. E. Kitchener, Rugby.

The Report of the Rugby School Natural History Society for 1871 lies before us. The preface refers with modest pride to several subjects of congratulation by the Society:—nearly all the published papers, some of them of considerable merit, are written by actual members of the school; a meteorological and astronomical section was begun in 1871, in consequence of the establishment of the Temple Observatory, and has been heartily carried out by those members of the school who were competent to serve; a large entomological section is springing up; the members of the Society have doubled during the year; and during the present spring each section has begun fortnightly meetings, from which all but real workers are to be excluded. Every year shows more and more the important place which the Natural History Societies of our public schools are taking in the scientific education of the country.

The Report of the Marlborough College Natural History Society, now eight years old, for the half-year ending Christmas, 1871, contains no paper bearing directly on the natural history of the district. That good local work is being done by members of the Society is, however, evidenced by the excellent list of entomological notices appended. We cannot unite with the sentence in the Preface that "it is an almost utter impossibility to get any original matter from beginners, and it would be unreasonable to expect any." It ought to be the special aim of school Natural History Societies to cultivate original work rather than mere collecting; the opportunities for it, even for beginners, are endless; and there is no over-estimating the value to the observer of the least morsel of such original work. The papers printed in this Report are excellent in their way; Mr. Babington's on "The Malay Archipelago and its Inhabitants," is a model of what such a paper should be. The Report is illustrated by an admirable plate of *Clavaria fusiformis*, drawn by Mr. F. C. Hulme. We would venture to suggest to the Committee the propriety of excluding in future from a published report personal matters, which, though of great importance to the Society itself, do not interest the outside public.

The Royal Cornwall Polytechnic Society has published its thirty-ninth Annual Report for 1871. Among the more important lectures and papers contained in it may be mentioned "On the Comparative Health and Longevity of Cornish Miners," containing a large number of very valuable statistics, by Mr. R. Blee; and the "Meteorology of West Cornwall and the Scilly Islands for 1871," by Mr. W. P. Dymond, besides descriptions of a number of mechanical inventions and applications especially valuable to those engaged in mining operations.

The first excursion of the Geologists' Association to Watford took place on April 13, under the guidance of Messrs. W. Whitaker and J. Hopkinson. The first section visited was a fine one of the Glacial Drift now exposed by the side of the railway near Watford to a depth of 30 feet. The drift is the "Middle Glacial," and consists of sand and sub-angular gravels with pebbles of various rocks, some of which are evidently from very distant localities. After passing through Cassiobury Park, the party proceeded to Bushey Heath, at which place the "Basement Bed" of the London Clay is exposed, with the upper portion of the Woolwich and Reading series. This section was described by Mr. Whitaker, as was also one at Bushey Heath Kiln, where the Woolwich and Reading series is again seen The formation is, however, represented by beds of sand at the former place, and by pebble beds at the latter. The next excursion was to Hampstead on April 27, directed by Messrs. J. R. Pattison and C. Evans. The party assembled at the Swiss Cottage station, and crossed the fields to Hampstead; but before the village was reached the structure of the hill was described, and the indications of the junction of the London Clay and the Bagshot Sands were observed. The summit of the hill consists of an outlier of the Bagshot Sands overlying the uppermost sandy beds of the London Clay, containing *Pectunculus decussatus* and *Voluta nodosa*. The Conduit spring was visited, and the line of junction of the two formations, indicated by springs and pools, was followed as far as the Vale of Health pond. The highest point of the Heath was then soon gained, and here the physiography of the district was pointed out. After passing through the West Heath valley, in which a thin bed of water-bearing sand above the clay has produced a swamp, the party visited the residence of Mr. C. Evans, and inspected that gentleman's fine collection of Tertiary fossils.

THE new School of Science and the new Museum and Art Gallery at the rear of the Hartley Hall, Southampton, are fast approaching completion. There are two class rooms of about 20ft. by 16ft. 6in. and 16ft. high, and a large drawing-class room, 32ft. by 16ft. 6in. and 16ft. high. In the Art Gallery and Museum are two large rooms, 42ft. by 20ft., and about 18ft. high, lighted from the roof and connected with the Science School and the Art School.

A FREE Museum has lately been opened at Nottingham in Wheeler-Gate. The greater portion of the objects of interest which are in the museum, now the property of the town, originally belonged to the Nottingham Naturalists' Society, and a considerable number of valuable objects were added from time to time until the museum assumed its present dimensions.

ACCORDING to the Stockholm *Aftonbladet* an important discovery has been made in Sweden. An extensive coal-bed of remarkable depth and excellent quality has been struck near Raus, in Schonen. An enterprising company formed some time ago was encouraged by promising geological indications to institute borings, but the first results were hardly satisfactory. At a depth of 566ft. eleven strata of coal had indeed been pierced, but none of these exceeded in depth 1¼ft. Five feet farther down, however, a bed was struck with a thickness of 8¾ft. The borings have been continued, and are believed to prove satisfactorily the existence of an extensive coal-bed.

A MOST violent cyclone occurred at Madras on May 1. Many vessels were driven on shore, and completely wrecked. The pier has been again breached, and great damage done to the city and suburbs. On Friday, the 3rd, the storm was slightly abating.

AT a recent sitting of the French Academy a letter was read from the French Consular agent at Mostar on the earthquakes felt throughout the Herzegovina during the months of February and March last. The first was felt on the 6th of February, two days after the great aurora borealis. Other oscillations followed on the 7th and 8th, apparently in a N.W. and S.E. direction On the 13th a longer shock was experienced, followed by a loud rumbling sound like distant cannon. On the 25th and 27th stronger shocks, accompanied by noise, were felt, making about forty since the 6th. On March 2 and 3 the manifestations increased in intensity; but neither Ragusa nor Serajevo, so subject to earthquakes, appear to have been at all affected all the time.

SOME time in the summer of 1871 it was stated that Mr. Octave Pavé, a young Louisiana Frenchman, had started toward the North Pole by way of Siberia and Wrangell's Land, and that, in the absence of news from him, the assistance of the Siberian Government had been invoked, in consequence of grave fears for his safety. It now appears that he has not yet started on his mission, but is to sail from San Francisco in May for Kamschatka, where he will take in supplies, and proceed to Cape Yakan, on the north-east coast of Siberia. Here the vessel is to be abandoned, and a further exploration attempted on an India-rubber raft, composed of four rubber cylinders fastened together on the decks by wooden slats, to which the masts and rigging are attached. It is intended to head, after leaving Cape Yakan, for Wrangell's Land, a large island discovered by Captain Long in 1867. This being reached, the island is to be crossed on sledges; and if an open sea occur beyond, he is to take the raft again, and endeavour to sail to Greenland or Spitzbergen. The entire enterprise is conducted at the expense of the traveller; and however hazardous or chimerical the plan may be, we cannot but wish him success in his movements.

HISTORY OF THE NAMES CAMBRIAN AND SILURIAN IN GEOLOGY*

(*Continued from page* 17)

WHAT then was the value and the significance of the Silurian sections of Murchison, when examined in the light of the results of the Government surveyors? The Llandeilo rocks, having throughout the characteristic *Orthis* so much insisted upon by Murchison, were shown to be the base of a great conformable series, and to the eastward, in Shropshire, to rest on the upturned edges of the Longmynd rocks; while westward, near Bala, they overlie unconformably the Lingula-flags, and in the island of Anglesea repose directly upon the ancient crystalline schists. According to the author of the "Silurian System," there existed beneath the base of the Llandeilo formation a great conformable series of slaty rocks into which this formation passed, and from which it could not be distinguished either zoologically, stratigraphically, or lithologically. The sequence, determined from what were considered typical sections in the valley of the Towey in Caermarthenshire, as given by Murchison, for several years both before and after the publication of his work, was as follows:—1. Cambrian; 2. Llandeilo flags; 3. Caradoc sandstone; 4. Wenlock and Ludlow beds; 5. Old Red sandstone; the order being from north-west to south-east. What then were these fossiliferous Cambrian beds underlying the Llandeilo and indistinguishable from it? Sedgwick, with the aid of the Government surveyors, has answered the question in a manner which is well illustrated in his ideal section across the valley of the Towey. The whole of the Bala or Caradoc group rises in undulations to the north-west, while the Llandeilo flags at its base appear on an anticlinal in the valley, and are succeeded to the south-east by a portion of the Bala. The great mass of this group on the south-east side of the anticlinal is however concealed by the overlapping May Hill sandstone—the base of the unconformable upper series which includes the Wenlock and Ludlow beds. (Philos. Mag. IV. viii. 488.) The section to the south-east, commencing from the Llandeilo flags on the anticlinal, was made by Murchison the Silurian system, while the great mass of strata on the north-west side of the Llandeilo (which is the complete representative of the Caradoc or Bala beds, partially concealed on the south-west side) was supposed by him to lie beneath the Llandeilo, and was called Cambrian (the Upper Cambrian of Sedgwick). These rocks, with the Llandeilo at their base, were in fact identical with the Bala group studied by the latter in North Wales, and are now clearly traced through all the intermediate distance. This is admitted by Murchison, who says:—"The first rectification of this erroneous view was made in 1842 by Prof. Ramsay, who observed that instead of being succeeded by lower rocks to the north and west, the Llandeilo flags folded over in those directions, and passed under superior strata, charged with fossils which Mr. Salter recognised as well-known types of the Caradoc or Bala beds." ("Siluria," 4th ed., p. 57, foot-note.)

The true order of succession in South Wales was in fact:—1. Llandeilo; 2. Cambrian (= Caradoc or Bala); 3. Wenlock and Ludlow; 4. Old Red sandstone; the Caradoc or Bala beds being repeated on the two sides of the anticlinal, but in great part concealed on the south-east side by the overlapping May Hill or Upper Llandovery rocks. These latter, as has been shown, form the true base of the upper series which, in the Silurian sections, was represented by the Wenlock and Ludlow. Murchison had, by a strange oversight, completely inverted the order of his lower series, and turned the inferior members upside down. In fact, the Llandeilo flags, instead of being, as he had maintained, superior to the Cambrian (Caradoc or Bala) beds, were really inferior to them, and were only made Silurian by a great mistake. The Caradoc, under different names, was thus made to do duty at two horizons in the Silurian system, both below and above the Llandeilo flags. Nor was this all; for by another error, as we have seen, the Caradoc in the latter position was made to include the Pentamerus beds of the unconformably overlying series. Thus it clearly appears that, with the exception of the relations of the Wenlock and Ludlow beds to each other and to the overlying Old Red sandstone, which were correctly determined, the Silurian system of Murchison was altogether incorrect, and was moreover based upon a series of stratigraphical mistakes, which are scarcely paralleled in the history of geological investigation.

It was thus that the Lower Silurian was imposed on the scientific world; and we may as well ask with Sedgwick, whether

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geologists "would have accepted the Lower Silurian classification and nomenclature, had they known that the physical or sectional evidence upon which it was based had been from the first positively misunderstood." Feeling that his own sections were, as has since been fully established, free from error, Sedgwick naturally thought his name of Upper Cambrian should prevail for the great Bala group. Hence the long and embittered discussion that followed, in which Murchison in many respects occupied a position of vantage as against the Cambridge professor, and finally saw his name of Lower Silurian supplant almost entirely that of Upper Cambrian given by Sedgwick, who had first rightly defined and interpreted the geological relations of the group.

In a paper read before the Geological Society in June, 1843 (Proc. Geol. Soc. iv. 212-223), when the perplexity in which the relations of the Upper Cambrian and Silurian rocks were involved had not been cleared up by the discovery of Murchison's errors in stratigraphy, Sedgwick proposed a compromise, according to which the strata from the Bala limestone to the base of the Wenlock were to take the name of Cambro-Silurian; while that of Silurian should be reserved for the Wenlock and Ludlow beds, and for those below the Bala the name of Cambrian should be retained. The Festiniog group (including what were subsequently named the Lingula flags and the Tremadoc slates) would thus be Upper instead of Middle Cambrian, the original Upper Cambrian being hence-forth Cambro-Silurian; it being understood that, wherever the dividing line might be drawn, all the groups above it should be called Cambro-Silurian, and all those below it Cambrian. This compromise was rejected by Murchison, who in the map accompanying the first edition of his "Siluria," in 1854, extended the Lower Silurian colour so as to include all but the lowest division of the Cambrian, viz., the Bangor group. When, however, the relations of Upper Cambrian and Silurian were made known by the discoveries of Sedgwick and the Government surveyors, this compromise was seen to be uncalled for, and was withdrawn in 1854 by Sedgwick, who re-claimed the name of Upper Cambrian for his Bala group.

In June 1843, Sedgwick proposed that the whole of the fossiliferous rocks below the horizon of the Wenlock should be designated Protozoic, and on Nov. 29, 1843, presented to the Geological Society an elaborate paper on the Older Palæozoic (Protozoic) Rocks of North Wales, with a coloured geological map. This paper, which embodied the results of the researches of Sedgwick and Salter, was not, however, published at length, but an abstract of it was prepared by Mr. Warburton, then president of the society, with a reduced copy of the map (Proc. Geol. Soc. iv. 212 and 251-268; also Geol. Jour. i. 5-22). In this map of Sedgwick's three divisions were established, viz., the hypozoic crystalline schists of Caernarvonshire, the Protozoic, and the Silurian. On the legend of the reduced map, as published by the Geological Society, these latter names were altered so as to read "Lower Silurian (Protozoic)" and "Upper Silurian." These changes, in conformity with the nomenclature of Murchison, were, it is unnecessary to say, made without the knowledge of Sedgwick, who did not inspect the reduced and altered map until it was appealed to as an evidence that he had abandoned his former ground, and had recognised the equivalency of the whole of his Cambrian with the Lower Silurian of Murchison. The reader will sympathise with the indignation with which Sedgwick declares that his map was "most unwarrantably tampered with," and will, moreover, learn with surprise that an inspection of the proof sheets of Warburton's abstract of Sedgwick's paper was refused him, notwithstanding his repeated solicitations. The story of all this, and finally of the refusal to print in the pages of the *Geological Journal* the reclamations of the venerable and aggrieved author, make altogether a painful chapter, which will be found in the *Philos. Magazine* for 1854 (IV. viii. pp. 301-317, 359-370, and 483-506), and more fully in the "Synopsis of British Palæozoic Rocks," which forms the introduction to McCoy's "British Palæozoic Fossils."

In connection with this history it may be mentioned that in March 1845 Sedgwick presented to the Geological Society a paper on the Comparative Classification of the Fossiliferous Rocks of North Wales and those of Cumberland, Westmoreland, and Lancashire, which appears also in abstract in the same volume of the *Geological Journal* that contains the abstract of the essay and the map just referred to (i. 442). That this abstract also is made by another than the author is evident from such an expression as "the author's opinion seems to be grounded on the following facts," &c. (p. 448), and from the manner in which the terms Lower and Upper Silurian are applied to certain fossiliferous rocks in Cumberland. Yet the words of this abstract are quoted with emphasis in "Siluria" (1st ed., 147), as if they were Sedgwick's own language, recognising Murchison's Silurian nomenclature.

II.—*Middle and Lower Cambrian*

Investigations in continental Europe were, meanwhile, preparing the way for a new chapter in the history of the lower palæozoic rocks. A series of sedimentary beds in Sweden and Norway had long been known to abound in singular petrifications, some of which had been examined by Linnæus, who gave to them the name of *Entomolithi.* They were also studied and described by Wahlenberg and by Brongniart, the latter of whom, from two varieties of the *Entomolithus paradoxus*, Linn, established in 1822 two genera, *Paradoxides* and *Agnostus.* In 1826 appeared a memoir by Dalman on the Palæadæ, or so-called Trilobites; which was followed, in 1828, by his classic work on the same subject ("Ueber die Palæaden oder so-genannten Trilobiten," 4to, with six plates, Leipsic). In these works were described and figured, among many others, two genera—*Olenus*, which included *Paradoxides* Brongn. and *Battus*, including *Agnostus* of the same author. Meanwhile, Hisinger was carefully studying the strata in which these Trilobites were found in Gothland, and in the same year (1828) published in his *Anteckningar*, or Notes on the Physical and Geognostical Structure of Norway and Sweden, a coloured geological map and section of these rocks as they occur in the county of Skaraborg, where three small circumscribed areas of nearly horizontal fossiliferous strata are shown to rest upon a floor of old crystalline rocks, in some parts granitic and in other gneissic in character. The section and map, as given by Hisinger, show the succession in the principal area to be as follows, in ascending order: (1) granite or gneiss, (2) sandstone, (3) alum-slates, (5) orthoceratite limestones, (4) clay-slates. By a curious oversight the colours on the legend are wrongly arranged and wrongly numbered, as above; for in the map and section it is made clear that the succession is that just given, and that the clay-slates (4) instead of being below, are above the orthoceratite-limestones (5).

In 1837 Hisinger published his great work on the organic remains of Sweden, entitled *Lethæa Suecica* (4to, with forty-two plates). In this he gives a tabular view, in descending order, of the rock-formations, and of the various genera and species described. The rocks of the areas just noticed appear in his fourth or lowest division, under the head of *Formationes Transitionis*, and are divided as follows:—

a. Strata calcarea recentiora Gottlandiæ.
b. Strata schisti argillacei.
c. Strata schisti aluminaris.
d. Strata calcarea antiquiora.
e. Strata saxi arenacei.

The succession thus given was however erroneous, and probably, like the mistake in the legend of the same author's map just mentioned, the result of inadvertence, the true position of the alum-slates (*c*) being between the older limestone (*d*) and the basal sandstone (*e*). This is shown both by Hisinger's map of 1828, and by the testimony of subsequent observers. In Murchison's work on the Geology of Russia in Europe, published in 1845, there is given (p. 15 *et seq.*) an account of his visit to this region in company with Prof. Loven, of Christiania; which, with figures of the sections, is reproduced in the different editions of "Siluria." The hill of Kinnekulle, on Lake Wener, is one of the three areas of transition rocks delineated on the mad of Hisinger above referred to. Resting upon a flat region of nearly vertical gneissic strata, we have according to Murchison, (1) a fucoidal sandstone, (2) alum-slates, (3) red orthoceratite limestone, (4) black graptolitic slates, the whole series being little over 1,000 ft. in thickness, and capped by erupted greenstone. Above these higher slates there are found in some parts of Gothland, other limestones with orthoceratites, trilobites, and corals, the newer limestone strata (*a*) of Hisinger; the whole overlain by thin sandstone beds. These higher limestones and sandstones contain the fauna of the Wenlock and Ludlow of England; while the lower limestones and graptolitic slates afford *Calymene Blumenbachii*, *Orthis calligramma*, and many other species common to the Bala group of North Wales. The alum-slates below these however contained, according to Hisinger, none of the species then known in British rocks, but in their stead five species of *Olenus* and two of *Battus* (*Agnostus*).

In 1854 Angelin published his *Palæontolologica Scandinavica*, part 1, *Crustacea formationis transitionis* (4to, forty-one plates), in which he divided the series of transition rocks above described by Hisinger into eight parts designated by Roman numerals, counting from the base. Of these I. was named *Regio Fucoidarum*, no organic remains other than fucoids being known therein; while the remaining seven were named from their characteristic genera of trilobites, which were as follows, in ascending order; certain letters being also used to designate the parts:—II. (A) Olenus: III. (B) Conocoryphe; IV. (BC) Ceratopyge; V. (C) Asaphus; VI. (D) Trinucleus; VII. (DE) Harpes; VIII. (E) Cryptonymus. In the *Regio Olenorum* (II.) was found also the allied genus *Paradoxides*. With regard to the characteristic genus of Regio III., the name of *Conocoryphe* was proposed for it by Corda in 1847, as synonymous with Zenker's name of *Conocephalus* (*Conocephalites*), already appropriated to a genus of insects.

Meanwhile the similar crustaceans which abound in the transition rocks of Bohemia had been studied and described by Hawle, Corda, and Beyrich, when Barrande began his admirable investigations of this ancient fauna and of its stratigraphical relations. He soon found that beneath the horizon characterised by fossils of the Bala group (Llandeilo and Caradoc) there existed in Bohemia a series of strata distinguished by a remarkable fauna, entirely distinct from anything known in Great Britain, but closely allied to that of the alum-slates of Scandinavia, corresponding to Regiones II. and III. of Angelin. To this he gave the name of the first or primordial fauna, and to the rocks yielding it that of the Primordial Zone. Resting upon the old gneisses of Bohemia appears a series of crystalline schists designated by Barrande as *Etage A*, overlain by a series of sandstones and conglomerates, *Etage B*, upon which repose the fossiliferous argillites of the Primordial Zone or *Etage C*. The rocks of the Etages A and B were by Barrande regarded as azoic, but in 1861, Fritsch of Prague, after a careful search, discovered in certain thin-bedded sandstones of B the traces of filled-up vertical double tubes; which, according to Salter (Mem. Geol. Sur. iii. 243), are probably the marks of annelides, and are identical with those found in the rocks of the Bangor or Longmynd group in Great Britain; which will be shown to belong to the Primordial Zone. It is, therefore, probable that the Etage B, which apparently corresponds to the Regio Fucoidarum or basal sandstone of Scandinavia, should itself be included in the Primordial Zone. It may here be noticed that it is in the crystalline schists of A that Gümbel has found *Eozoön bavaricum*. To the Etage C in Bohemia, Barrande assigns a thickness of about 1,200 feet, and to this his first fauna is confined, while in the succeeding divisions he distinguished a second and a third. The second fauna, which characterises Etage D, corresponds to that of the Bala group; while the third fauna, belonging to the Etages E, F, G, and H, is that of the May Hill, Wenlock, and Ludlow formations of Great Britain.

This classification of the ancient Bohemian faunas was first set forth by Barrande in 1846, in his *Notice Préliminaire*, in which he declared that the first fauna was below the base of the Llandeilo of Murchison, unknown in Great Britain, and, moreover, "new and independent in relation to the two Silurian faunas (his second and third) already established in England." This opinion he reiterated in 1859. These three divisions form in Bohemia an apparently continuous series, and being connected with each other by some common species, Barrande was led to look upon the whole as forming a single stratigraphical system; and finally to assert that these three independent faunas "form by their union an indivisible triad which is the Silurian system." (Bul. Soc. Geol. de Fr. II. xvi. 529-545.) Already, in 1852, in his magnificent work on the Silurian System of Bohemia, Barrande had given to the strata characterised by his first fauna the name of Primordial Silurian. It is difficult to assign any just reason for thus annexing to the Silurian—already augmented by the whole Upper Cambrian or Bala group of Sedgwick, (Llandeilo and Caradoc)—a great series of fossiliferous rocks lying below the base of the Llandeilo, and unsuspected by the author of the Silurian system; who persistently claimed the Llandeilo beds, with their characteristic second fauna, as marking the dawn of organic life.

Up to this time the primordial palæozoic fauna of Bohemia and of Scandinavia was, as we have said, unknown in Great Britain. The few organic remains mentioned by Sedgwick in 1835 as occurring in the region occupied by his Lower and Middle Cambrian, on Snowdon, were found to belong to Bala beds, which there rest upon the older rocks; nor was it until 1845 that Mr. Davis found in the Middle Cambrian remains of *Lingula*. In 1846, Sedgwick, in company with Mr. Davis, re-examined these rocks, and in December of the same year described the Lingula beds as overlaid by the Tremadoc slates and occupying a well-defined horizon in Caernarvon and Merionethshire, beneath the great mass of the Upper Cambrian rocks. (Geol. Jour. ii. 75, iii. 139.) Sedgwick, at the same time, noticed about this horizon certain Graptolites and an *Asaphus*, which were supposed to belong to the Tremadoc slates, but have since been declared by Salter to pertain to the Arenig or Lower Llandeilo beds, the base of the Upper Cambrian. (Mem. Geol. Sur. iii. 257, and Decade II.)

This discovery of the Lingula flags, as they were then named, and the fixing by Sedgwick of their geological horizon, was at once followed by a careful examination of them by the Government surveyors; and in 1847, Selwyn detected in the Lingula flags, near Dolgelly, in Merionethshire, the remains of two crustacean forms, the one a phyllopod, which has received the name of *Hymenocaris vermicauda* Salter, and the other a trilobite, which was described by Salter in 1849 as *Olenus micrurus*. (Geol. Survey, Decade II.) A species of *Paradoxides*, apparently identical with *P. Forchammeri* of Sweden, was also about this time recognised among specimens supposed to be from the same horizon. It has since been described as *P. Hicksii*, and found to belong to the basal beds of the Lingula flags—the Menevian group.

Upon the flanks of the Malvern Hills there are found resting upon the ancient crystalline rocks of the region, and overlain by the Pentamerus beds of the May Hill sandstone (originally called Caradoc by Murchison) a series of fossiliferous beds. These consist in their lowest part of about 600 feet of greenish sandstone, which have since yielded an *Obolella* and *Serpulites*, and are overlain by 500 feet of black schists. In these, in 1842, Prof. John Phillips found the remains of trilobites, which he subsequently described, in 1848, as three species of *Olenus* (Mem. Geol. Survey ii. part 1, 55). These black shales, which had not at that time furnished any organic remains, were by Murchison in his "Silurian System" (p. 416) in 1839 compared to the supposed passage beds in Caermarthenshire between the Llandeilo and the Cambrian (Bala) rocks; which, as we have seen, were newer and not older strata than the Llandeilo flags. From their lithological characters, and their relations to the Pentamerus beds, these lower fossiliferous strata of Malvern were subsequently referred by the Government geologists to the horizon of the Caradoc proper or Bala group; nor was it until 1851 that their true geological age and significance were made known. In that year, Barrande, fresh from the study of the older rocks of the Continent, came to England for the purpose of comparing the British fossils with those of the Primordial Zone which he had established in Bohemia and Scandinavia, and which he at once recognised in the Lingula flags of Sedgwick and in the black schists at Malvern; both of which were characterised by the presence of the genus *Olenus*, and were referred to the horizon of his Etage C. This important conclusion was announced by Salter to the British Association at Belfast in 1852 (Rep. Brit. Assoc., abstracts, p. 56, and Bull. Soc. Geol. de Fr. II. xvi. 537). Since that time the progress of investigation in the Middle and Lower Cambrian rocks of Wales has shown a fauna the importance and richness of which has increased from year to year.

The palæontological studies of Salter, while they confirmed the primordial character of the whole of the great mass of strata which make up the Middle Cambrian or Festiniog group of Sedgwick (consisting of the Lingula flags and the Tremadoc slates), led him to propose several sub-divisions. Thus he distinguished on palæontological grounds between the upper and lower Tremadoc slates, and for like reasons divided the Lingula flags into a lower and an upper portion. For the discussion of these distinctions the reader is referred to the memoirs of the Geol. Survey (iii. 240-257). Subsequent researches led to the division of the original Lingula flags into three parts, an upper and a middle, to which the names of Dolgelly and Maentwrog were given by Mr. Belt, and a third consisting of the basal beds, which were separated in 1865 by Salter and Hicks, with the designation of Menevian, derived from the ancient Roman name of St. David's in Pembrokeshire. It was here that in 1862, Salter found *Paradoxides* with *Agnostus* and *Lingula* in fine black shales at the base of the Lingula flags, resting conformably on the green and purple grits of the Lower Cambrian or Harlech beds. The locality was afterwards carefully studied by Hicks, and it was soon made apparent that the genus *Paradoxides*, both here and in North Wales, was confined to a horizon below the great mass of the Lingula flags, which, on the contrary, are characterised by numerous species of *Olenus*. These lower or Menevian beds are hence regarded by Salter as equivalent to the lowest portion of the Etage C of Barrande.

Beneath these Menevian beds there lies, in apparent conformity, the great Lower Cambrian series, frequently called the bottom or basement rocks by the Government surveyors; represented in North Wales by the Harlech grits, and in South Wales, near St. David's, by a similar series of green and purple sandstones, considered by Murchison and by others as the equivalent of the Harlech rocks. They were still supposed to be unfossiliferous until, in June 1867, Salter and Hicks announced the discovery in the red beds of this lower series, at St. David's, of a *Lingulella*, very like *L. ferruginea* of the Menevian (Geol. Jour. xxiii. 339; Siluria, 4th ed. 550). This led to a further examination of these Lower Cambrian beds, which has resulted in the discovery in them of a fauna distinctly primordial in type, and linked by the presence of several identical fossils to the Menevian; but in many respects distinct, and marking a lower fossiliferous horizon than anything known in Bohemia or in Scandinavia.

The first announcement of these important results was made to the British Association at Norwich in 1868. Further details were, however, laid before the Geological Society in May 1871 by Messrs. Harkness and Hicks, whose paper on the Ancient Rocks of St. David's Promontory appears in the Geological Journal for November 1871 (xxviii. 384). The Cambrian sediments here rest upon an older series of crystalline stratified rocks, described by the geological surveyors as syenite and greenstone, and having a north-west strike. Lying unconformably upon these, and with a north-east strike, we have the following series, in ascending order:—1, quartzose conglomerate, 60ft.; 2, greenish flaggy sandstone, 460ft.; 3, red flags or slaty beds, 50ft., containing *Lingulella ferruginea*, besides a larger species, *Discina*, and *Leperditia cambrensis*; 4, purple and greenish sandstones, 1,000ft.; 5, yellowish gray sandstones, flags and shales, 150ft., with *Plutonia*, *Conocoryphe*, *Microdiscus*, *Agnostus*, *Theca*, and *Protospongia*; 6, gray, purple and red flaggy sandstones, with most of the above genera, 1,500ft.; 7, gray flaggy beds, 150ft., with *Paradoxides*; 8, true Menevian beds, richly fossiliferous, 500ft. The latter are the probable equivalent of the base of Barrande's Etage C, and at St. David's are conformably overlain by the Lingula flags, beneath which we have, including the Menevian, a conformable series of 3,370ft. of uncrystalline sediments, fossiliferous nearly to the base, and holding a well-marked fauna distinct from anything hitherto known in Great Britain or elsewhere.

The Menevian beds are connected with the underlying strata by the presence of *Lingulella ferruginea*, *Discina pileolus*, and *Obolella sagittatus*, which extend through the whole series; and also by the genus *Paradoxides*, four species of which occur in the lower strata, from which the genus *Olenus*, which characterises the Lingula flags, seems to be absent. To a large tuberculated trilobite of a new genus found in these lowest rocks the name of *Plutonia Sedgwickii* has been given. Hicks has proposed to unite the Menevian with the Harlech beds, and to make the summit of the former the dividing line between the Lower and Middle Cambrian, a suggestion which has been adopted by Lyell. (Proc. Brit. Assoc. for 1868, p. 68, and Lyell, Student's Mannal of Geology, 466—469.)

Both Phillips and Lyell give the name of Upper Cambrian to the Lingula flags and the Tremadoc slates, which together constitute the Middle Cambrian of Sedgwick, and concede the title of Lower Silurian to the Bala group or Upper Cambrian of Sedgwick. The same view is adopted by Linnarsson in Sweden, who places the line between Cambrian and Silurian at the base of the Llandeilo or the second fauna. It was by following these authorities that I, inadvertently, in my address to the American Association for the Advancement of Science in August 1871, gave this horizon as the original division between Cambrian and Silurian. The reader of the first part of this paper will see with how much justice Sedgwick claims for the Cambrian the whole of the fossiliferous rocks of Wales beneath the base of the May Hill sandstone, including both the first and the second fauna. I cannot but agree with the late Henry Darwin Rogers, who, in 1856, reserved the designation of "the true European Silurian" for the rocks *above* this horizon. (Keith Johnston's Physical Atlas, 2nd ed.)

T. Sterry Hunt

(*To be continued*)

*ACOUSTICAL EXPERIMENTS**

Showing that the Translation of a Vibrating Body causes it to give a Wave-length differing from that produced by the same Vibrating Body when Stationary

The Apparatus

FOUR tuning-forks mounted on resonant cases and giving the note UT^3, = 256 complete vibrations per second, were obtained. I will designate them as Nos. 1, 2, 3, and 4.

Nos. 1 and 2 were brought into perfect unison by a process to be described.

No. 1 was placed before a lantern, and just touching one of its prongs was a small ball (5 or 6^{mm} diam.) of good cork, suspended by a silk fibre. The images of the fork and of the cork ball were projected on a screen.

No. 3 had one prong weighted with wax, so that it gave two beats a second with No. 1 or 2.

No. 4 had the ends of its prongs filed off, until it also gave two beats per second with 1 or 2; thus No. 4 gave two vibrations a second more than No. 1, while fork No. 3 gave two vibrations a second less than No. 1.

The Experiments

In the experiments one to seven inclusive, fork No. 1 remains before the lantern, with the suspended cork ball just touching one of its prongs.

Exp. 1. Fork No. 2, screwed on its case, was held in the hand, at a distance of 30 to 60 ft. from No. 1, and sounded; the ball was projected from the prong of fork 1, which vibrated in unison with 2.

Exp. 2. I stationed myself 30 ft. distant from fork No. 1, and fork No. 2 was screwed off its case and vibrated in one hand, while the case was held in the other. I now walked rapidly toward fork 1, and after I was in regular motion I placed the fork on its case, and just before I ceased walking I took it off; although, when I did so, I was only about a foot from fork 1, yet the cork ball remained at rest against its prong.

Exp. 3. Again I walked toward 1, as in Exp. 2, but I did not remove the fork from its case after it was placed on it. The ball remained at rest until the moment I suddenly stopped walking; at that instant the ball flew from the fork, while an assistant, whose ear was close to the case of fork 1, while his eye was directed to the screen, found that at the instant I stopped walking, the fork 1 sounded, while the ball jumped from its prong.

Exps. 4 and 5. These experiments were exactly like Exps. 2 and 3, except that I walked away from fork 1 instead of approaching it. The results were the same as in Exps. 2 and 3.

Exp. 6. Fork No. 3, giving 254 vibrations per second, was sounded as in Exp. 1. It had no effect in moving the ball. I now screwed the fork off its case, and, standing about 30 ft. from fork 1, with my arm I swung the case toward fork 1, and while it was approaching it I placed fork No. 3 on the case; the proper velocity (from eight to nine feet per second) having been obtained, the ball was suddenly projected from fork 1. On greatly increasing or decreasing the above velocity of the moving case, the vibrations of fork 3 produced no effect on fork 1.

Exp. 7. Fork No. 4, which gives two vibrations per second more than No. 1, was substituted in Exp. 6, but was placed on its swinging case when this was receding from fork 1. The effect of this motion and of varying velocities was the same as in Exp. 6.

Exp. 8. I placed fork 3 before the lantern, and swung fork 1 as in Exp. 7. The effects were the same as described in Exp. 7.

Exp. 9. I now placed fork 4 before the lantern, and moved fork 1 as in Exp. 6. The effect on the ball was the same as in Exp. 6.

By these simple experiments I have shown the change of wave-length produced by the translation of the vibrating body, and have given an experimental proof of the important theorem which Doppler established in 1841. By analogy they clearly unfold that exquisite modern method of determining the motions

* By Alfred M. Mayer, Ph.D., Professor of Physics in the Stevens Institute of Technology, Hoboken, New Jersey (reprinted from the *American Journal of Science and Arts*, vol. iii., April, 1872).

of a heavenly body by variations in the refrangibility of the rays which it emits—motions often impossible even to detect by any other means. I therefore deem it proper that I should proceed to state the delicate conditions on which depend the perfection of experiments which so satisfactorily elucidate the nature of those grand and refined problems offered to spectral observation.

It is, first of all, essential that forks 1 and 2 should really be in unison. Two forks, sounded together, may give no perceptible beats, for they may constrain each other into a common forced oscillation, and thus both will give the same number of vibrations, yet may be removed from equality when separately vibrated. The process I have adopted is as follows: Three forks are taken which are supposed to give the same number of vibrations in a given time. They are supported on india-rubber tubing, and are thus insulated. One of the forks is now loaded so that it gives two or three beats in a second, with one of the other two that are to be brought into exact unison. The interval of time occupied by twenty or thirty of these beats is accurately determined by means of a chronograph (one of Casella's registering stop-watches does very well). The interval occupied by the same number of beats given with the second fork is now ascertained, and if it differs from that given by the first, the quicker vibrating fork is made to give the same number of beats as the slower by loading it with wax. When the forks have thus been carefully adjusted, I have had no difficulty in projecting the ball, in Exp. 1, at a distance of sixty feet, and I believe that it could have been accomplished at a distance of 100 feet. The ball of cork should be *spherical*, so that it will always just touch the fork, no matter how much it may rotate around its suspending thread, which latter should consist of only one or two fibres of unspun silk. The cork is rendered as smooth as possible and is then *varnished*: this is important, for the varnish gives a firm coating to the ball, without sensibly increasing its weight, and is especially useful in covering the minute asperities or elastic projections on its surface, which otherwise would act as "buffers" to the impacts of the fork and deaden its projectile effects.

The above-stated conditions having been obtained, no physicist will have any difficulty in repeating these experiments.

A machine has been devised by which a uniform motion of translation can be given to the forks, and with this I propose making a quantitative investigation of the phenomena, using an apparatus essentially the same in its action as the one here described.

We may substitute for the suspended cork-ball a light plane mirror, held between two stretched vertical fibres, while one of its edges touches the fork. The motions of a beam of light reflected from the mirror to a screen, indicate most beautifully the vibrations of the fork. This ingenious and most delicate device for detecting vibrations is due to Prof. O. N. Rood, of Columbia College, N.Y., who first used it in a public lecture, delivered in New York on the 28th of last December. We have, however, in our special work, found the image of the projected ball more convenient, and sufficiently delicate, for our experiments.

Quantitative relations in the experiments and analogical facts in the phenomena of light.

The UT_3, No. 1 fork, makes 256 complete vibrations in one second, while fork No. 3 makes 254, giving for the respective wave-lengths of these vibrations 4·367 and 4·401 feet, which we will designate in order as λ and λ'. We will take 1,118 feet per second as the velocity of sound at 60° F.

Now 256 vibrations in 1,118 ft. make $\lambda = 4{\cdot}367$ ft.
and 254 „ „ $1,118 - 2\lambda\ (= 1,109{\cdot}266)$ give $\lambda = 4,367$ ft.

As the velocity of propagation of the vibrations and λ are the same in both cases, it follows that $\left(n = \frac{V}{\lambda}\right)$, the number of vibrations in a second, reaching a distant point, is the same, and, therefore, 256 vibrations from a body at rest will produce the same effect on a distant surface, as 254 vibrations emanating from a body which moves toward that surface, with a velocity of 2λ, or of 8·734 feet per second; and this is the velocity we gave the fork in Exps. 6 to 9.

We will now examine the analogical phenomena in the case of light. Let fork No. 1, giving 256 vibrations a second, stand for 595 millions of millions vibrations a second, which we will take as the number of vibrations made by the ray D_1 of the spectrum. Then fork No. 3 will represent 590 millions of millions vibrations per second, which gave a wave-length ·0000042 millimetre longer than that of D_1, and nearly corresponds with an iron line situate ·42 div. below D_1 on Angström's chart. We saw that fork No. 3, giving 254 vibrations a second, had to move toward the ear with a velocity of 8·734ft., to give the note produced by 256 vibrations per second, emanating from a fixed point; so a star sending forth the ray which vibrates 590 millions of millions times a second, will have to move toward the eye with a velocity of 28,470 miles per second to give the colour produced when ray D_1 emanates from a stationary flame.

SCIENTIFIC SERIALS

Annalen der Chemie und Pharmacie, October 1871. Naumann has made a long series of experiments on the dissociation-tensions of ammonic carbonate, he finds that when it is volatilised it is entirely decomposed into ammonia and carbonic anhydride, and that for lower temperatures the dissociation-tensions of this body increase by increase of temperature precisely as the tensions of other substances. Leist has obtained three compounds of bismuth oxide with sulphuric acid, all of which are basic salts, he has not been able to form the normal salt except in combination with potassium. Faust has made a series of experiments on the derivatives of phthalic acid, he has obtained nitrophthalic, bromophthalic, and dechlorophthalic acids. Faust and Saame have made a careful examination of the chloro-compounds, both addition and substitution of naphthaline: this work has already been performed many years ago by Laurent; the authors have thought fit to commence a revision of the subject, but it is as yet far from complete. A very long paper by Schutzenberger follows "on the acetyl derivations of carbo-hydrates, mannite and its isomerides, and on certain vegetable products," this contains some interesting though complicated results. A translation of Dr. Mills' paper on the nitration of chloroform, and two other papers of less interest complete this number.

Annales de Chimie et de Physique, March 1872.—The greater portion of this number is occupied by the second part of MM. Pierre and Puchot's researches on some of the bodies produced in fermentation. They give the results of a very detailed study of propylic alcohol, its haloid ethers, the formiate, acetate, propionate, butyrate, and valerate, and propylic aldehyde; butylic alcohol and the same series of ethers as above, and amylic alcohol with its butyrate and valerate. Besides these we have the detailed description of several other ethers, methyl valerate, and ethyl propionate and valerate, forming altogether a very complete and exhaustive monograph on these subjects. The author has also made some interesting observations on the "simultaneous distillation of water with certain alcohols insoluble therein." Thus a mixture of water and amylic alcohol, when submitted to distillation, boils at 96°, and a definite proportion of the two bodies is found in the distillate, at this temperature 2 parts of water and 3 of amylic alcohol invariably condense; should the water be in excess the whole of the amylic alcohol will pass over, the thermometer remaining at 96°. Butylic alcohol and water distil over at 90·5° when a constant mixture of 5 parts of alcohol and 1 part of water condenses.—M. Bourgoin has electrolysed a solution of potassic phthalate, and finds that it splits up into water, carbonic oxide, and carbonic anhydride, an aqueous solution of phthalic acid does not appear to be decomposed by the electric current.

THE *Scottish Naturalist* for April contains a number of short articles on various branches of Scottish Natural History. Among the more interesting may be mentioned especially a note by Dr. Buchanan White on the discovery in Braemar of a colony of *Zygæna exulans*, a common moth in the Alpine districts of Southern Europe and in Scandinavia, but hitherto unknown in Britain. Dr. White considers it, like some of the characteristic plants of the district, a relic of the glacial epoch which once overspread Scotland; its characters are intermediate between the northern and southern forms.—Mr. George Sim contributes an important paper, comprising a list of the stalk-eyed Crustacea of the north-east coast of Scotland, with descriptions of new genera and species, and a plate.—The instalment of the catalogues of Insecta Scotica includes a continuation of the Lepidoptera by Dr. Buchanan White, and the commencement of the Coleoptera by Dr. D. Sharp.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 2.—"On some Elementary Principles in Animal Mechanics.—No. V On the most perfect form of a Plane Quadrilateral Muscle connecting two Bones.—No. VI. Theory of Skew Muscles, and investigation of the conditions necessary for Maximum Work." By Rev. Prof. Haughton, F.R.S.

"On the Rings produced by Crystals when submitted to Circularly Polarised Light." By William Spottiswoode, Treas. R.S.

Geological Society, April 24.—Prof. Ramsay, F.R.S. V.P. in the chair. 1. "An Extract from a Despatch from H.M. Minister in Teheran." This letter described the effects of some severe earthquake shocks experienced at Khabooshan in North-Western Khorassan. On December 23, 1871, an earthquake occurred which destroyed half the town of Khabooshan, and buried about 2,000 of its inhabitants in the ruins. On January 6, 1872, another severe shock destroyed the remainder of the town, and killed about 4,000 people. Four forts near the town were so completely buried that not a trace of them can be seen. It was estimated that 30,000 lives were lost in Khabooshan, Bojnoord, and the surrounding villages by the effects of these earthquakes. 2. "Notes on the Geology of the Colony of Queensland," by R. Daintree. The author stated that Allu vial deposits are very scanty in Queensland, except on the northern shores of Carpentaria and near the mouths of the larger rivers. The fossil remains of extinct Mammalia (*Diprotodon*, *Macropus*, *Thylacoleo*, *Nototherium*, &c.) are found in old brecciated alluvia, representing beds of old watercourses, through which modern creeks have cut their channels. With these mammalia are found shells of existing species. Of Cainozoic deposits the most important is called the "Desert Sandstone" by the author; it consists of horizontal beds of coarse grit and conglomerate, nowhere exceeding 400 feet in thickness, forming a sandy barren soil by their disintegration. The only fossils found in it are rolled fragments of coniferous wood; and its stratigraphical position is determined solely by its resting unconformably upon beds containing apparently Cretaceous fossils. The author considered that this deposit formerly covered nearly the whole of Australia. Beds containing Mesozoic forms of fossils, and referred by the author to the Cretaceous series, occur upon the Upper Flinders. At Marathon these deposits consist of a fine-grained yellow sandstone, and below this a series of sandstones and argillaceous limestones, containing four species of *Inoceramus*, with a species of *Ichthyosaurus* and two of *Plesiosaurus*. At Hughenden station, near Mount Walker, there is a series of calcareo-argillaceous beds, probably inferior to those of Marathon, and containing two species of Ammonites, with *Avicula gryphæoides*, a *Pecten*, &c. At Hughenden Cattle Station, twenty miles farther up the river, numerous Belemnites are found loose upon the surface. The Mesozoic rocks also extend down the Thompson River and its tributaries. The author referred to the fossils described by Mr. Charles Moore as probably Oolitic, and stated that it is more than probable that Oolitic and Cretaceous rocks extend throughout the whole of Central Queensland, and thence to Western Australia. On the eastern side of the dividing range a small patch of ferruginous grit containing *Panopæa plicata* occurs near Pelican Creek; and from Gordon Downs species of *Panopæa*, *Pholadomya*, and *Cucullæa* have been obtained. These beds probably represent a lower horizon than those on the Flinders River; and a large portion of the colony east of the dividing range is covered by freshwater deposits, containing plant-remains (including *Tæniopteris*), and in their upper part a fauna apparently intermediate between the Gordon Downs and Flinders River series. In these deposits, on the Cnodamine, Brisbane, and Mary rivers, numerous Coal-seams exist. The author supposes that, contemporaneously with the deposition of a series of marine beds to the west of the dividing range, during the Oolitic and part of the Cretaceous period, a vast lacustrine deposit was accumulated over a large area to the eastward of the range, to which the sea subsequently obtained access. Among the Palæozoic deposits, the author distinguished Carboniferous and Devonian rocks. The *Carboniferous* series was said to be represented in Northern Queensland by an extensive Coal-field. The upper portion of the series (grits, sandstones, and shales) contains chiefly fossil plants, the most abundant being a *Glossopteris*. The lower strata (generally *argillaceous* limestone) contain *Producti*, *Spiriferæ*, &c. of true Carboniferous type, intermixed with scanty and imperfect remains of the above-mentioned plants. A set of fossils from the head of the Don River were said to agree with those found in the Hunter River series of New South Wales. *Devonian* rocks extend from 18° S. lat. to the southern boundary of Queensland and for 200 miles inland. They consist of slates, sandstones, and Coral-limestones. The upper portion of this series contains an abundance of fossil plants, the deposits containing which, at Mount Wyatt, are interstratified with beds containing *Spiriferæ*, and other fossils of Devonian type occur in beds reached by shafts sunk through these strata. In the limestone of the lower portion of the series corals are very numerous. On the Broken River this formation may be best studied. Gold is found in many parts of the Devonian district, and the author entered in considerable detail into its mode of occurrence there. Metamorphic rocks were described by the author as occurring in various localities. At the Cloncurry, Cape River, Gilbert, Peak Downs, Black Snake, Kilkwan, and Goaroomjain Diggings there are mica- and hornblende-schists, whilst at the Ravenswood Diggings the rock is a granite with triclinic felspar. The latter, which contains more or less hornblende, the author regarded as of metamorphic origin. The author noticed the connection between the presence of certain trappean rocks in these metamorphic areas and in the Devonian area, and the production of auriferous and cupriferous lodes. True *Granites* crop out along the eastern coast of Queensland, and these vary much, passing into porphyry and quartz-porphyry, but monoclinic felspar always predominates in them. The intrusive Trappean rocks, which are regarded as influencing the production of auriferous vein-stones in the Devonian and Metamorphic rocks, are noticed at considerable length by the author, and consist of pyritous porphyrites and porphyries, pyritous diorites and diabases, chrome-iron serpentines and pyritous felsites; the author considers that this order probably indicates the succession of these rocks in time. The veinstones he thinks were probably deposits of mineral matter from the hydrothermal action which preceded, accompanied, and continued long after the cooling of the traps themselves. The volcanic rocks, in the author's opinion, have played a most important part in determining the elevation and present physical outline of North-eastern Queensland; they follow the line of greatest elevation on the main watershed at altitudes of from 1,500 to 2,000 feet above the sea-level. The general arrangement of the other rocks referred to is epitomised by the author as follows:—"With the exception of the McKinlay ranges, a line drawn parallel with the eastern coast at a distance of 250 miles would include all the Palæozoic, Metamorphic, Granitic, Trappean, and Volcanic rocks represented in the colony, both coal-groups lying within the same area. The Mesozoic and Cainozoic systems occupy the surface area to the westward. The descent going eastward is first locally a thin capping of 'Desert Sandstone,' next Carboniferous, then Devonian, and possibly Silurian, with patches of metamorphic and granitic rocks interspersed. The chief granitic mass extends from Broad Sound to Cape York, with an occasional capping of 'Desert Sandstone.'" The paper contained numerous analyses of the various rocks, and the fossils have been worked out by Messrs. Etheridge and Carruthers, whose lists and descriptions of them are appended to the paper.

Linnean Society, May 2.—Mr. G. Bentham, president, in the chair.—Dr. Joseph Leidy, of Philadelphia, and Prof. Notaris, of Genoa, were elected to the two vacant places in the list of foreign members.—On *Alibertia edulis*, by Senor Correa de Mello. —Mr. Miers exhibited a substance which he had received from the Brazilian Government, which it was thought might, to a certain extent, become a substitute for cotton. It is a product of the liber of a climbing plant of unknown relationship, and can be procured in any quantity, furnishing a fibre of very strong and silky texture.

Anthropological Institute, May 6.—Sir John Lubbock, Bart., president, in the chair. The following papers were read:—"Note on the Peculiarities of the Australian Cranium," by Mr. S. M. Bradley, F.R.C.S.; "Notes on a Scaphoid Skull," by Dr. Barnard Davis, F.R.S.; "On Certain Points concerning the Origin and Relations of the Basque Race," by Rev. W. Webster and Mr. Stuart Menteath; "Mann: its names and their origins," by Mr. J. M. Jeffcott; "Vocabulary of Original Dialects of Queensland," by Mrs. Barlow; "On the Mode of Preparing the Dead among the Natives of the Upper Mary River, Queensland," by Mr. A. McDonald.

DUBLIN

Natural History Society, February 7.—Prof. E. Perceval Wright, M.D., in the chair.—The following gentlemen were elected as officers and council of the society for the present session:—President—Prof. E. Perceval Wright, M.D.; Vice-Presidents—Mr. William Archer, Dr. Alexander Carte, Dr. Robert M'Donnell, Lord Ventry; Honorary Treasurer—Mr. A. Andrews; Honorary Secretaries—Mr. William Andrews and Dr. A. W. Foot; Council—Mr. R. Ball, Mr. H. Barton, Rev. S. Haughton, M.D., M. A. Jacob, M.D., Mr. T. Kift, Mr. A. Macalister, M.B., Mr. D. Moore, Mr. M. Barrington, Mr. Edward Crowe, Dr. Fraser, Rev. T. O'Mahony, M.A., Rev. Eugene O'Meara, M.A., and Mr. George Porte. Dr. E. P. Wright returned thanks to the members for the honour they had conferred upon him, and stated that, at the suggestion of the Hon. Secretary, he would defer the introductory address to the next meeting of the Society.

KILKENNY

Royal Historical and Archæological Association of Ireland, April 3.—Rev. P. Moore in the chair.—The secretary exhibited an ancient ecclesiastical seal of the Primatial See of Armagh, and read a report on the state of the Round Tower of Kilmacduagh, County G lway. The following papers were read: "On the old Church of Donaghmore, County Limerick, with a photograph," by the Rev. M. Malone; "On the old Kilkenny Canal," by A. Walters; "On the Corrack or Ancient Wicker Boat covered with Skin," by W. F. Wakeman; "On an Ancient Bell found near the old Church of Drumrath, County Tyrone, with a photograph, and on a Silver Ring-brooch found in the Cran nog of Aghalougher, County Antrim," by J. Nolan.

VIENNA

Imperial Academy of Sciences, March 21.—Prof. Hlasiwetz presented a memoir by M. A. Exner, on the synthesis of hyponitric acid, N^2O^4.—Prof. Suess made a preliminary communication on the structure of the Italian Peninsula, in which he showed that the mountain chain which forms the Calabrian peninsula is a fragment of the tectonic axis of the peninsula, but that the continuation of this axis lies concealed under the Tyrrhenian sea. The southern half of the western part of the Alps is also sunk beneath the plain of Lombardy. The Appenines form the north-eastern, and Sicily a fragment of the south-western, subsidiary zone of the Tyrrhenian mountain chain; and the volcanoes stand for the most part either in series on the margins of fracture, or in groups in the middle of the regions of depression. The relation of the Hungarian trachytes to the Carpathians is the same as that of the Italian volcanoes to the Appenines.—Prof. E. Weiss reported upon the difference of longitude between the observatory of Vienna and that at the Military Academy of Wiener-Neustadt.—Dr. H. W. Reichardt reported upon the Botanical Results of the Polar Expedition of 1871. The number of species brought by Lieutenant Payer was about thirty; they were collected in the southern part of Spitzbergen and some adjacent islands, and in Hope Island.

BOOKS RECEIVED

ENGLISH.—Extracts from the 13th vol. of the Astronomical Observations made at the Royal Observatory, Edinburgh: C. P. Smyth (Neil and Co., Edinburgh).—Botany for Beginners, Dr. M. T. Masters (Bradbury and Evans).—Beeton's Science, Art, and Literature, a Dictionary of Universal Information, Vol. i. (Ward, Lock, and Tyler).—The Martyrdom of Man: Winwood Reade (Trübner and Co.).—Spiritualism Answered by Science, 2nd edition: E. W. Cox (Longmans).

PAMPHLETS RECEIVED

ENGLISH.—Journal of the Quekett Microscopical Club, April.—Concerning Sewage and its Economical Disposal: F. H. Danchell.—The Ukara Lake: R. F. Burton.—The Scottish Naturalist, April.—Quarterly Journal of Science, April.—Journal of the Statistical Society, March.—A Series of Chemical Labels for Use in Laboratories: Mottershead.—University of Cambridge: Report of the Museums and Lecture Rooms Syndicate.—On the Curability of Cancer: Dr. G. von Schmidt.—Proceedings of the Cleveland Institute of Engineers, March.—Currents and Surface Temperature of the North Atlantic Ocean.—Proceedings of the Bristol Naturalists' Society, 1871.—An Appeal to Reason to Reform Itself.—39th Annual Report of the Royal Cornwall Polytechnic Society, 1871.—The Miners' Association of Devon and Cornwall, Report of Annual Meeting.—Report of the Rugby School Natural History Society, 1872.—Quarterly Journal of Microscopical Science, April.—Proceedings of the Royal Physical Society of Edinburgh, 1870-71.—On Teaching Geology and Botany as part of a Liberal Education: J. M. Wilson.—Annual Report of the Maidstone and Mid-Kent Natural History and Philosophical Society, 1871.

AMERICAN AND COLONIAL.—Third Annual Report of the State Board of Health, Massachusetts.—On two new Ornithosaurians from Kansas: E. D. Cope.—Some Phases of Modern Philosophy: E. K. Price.—The Use and Origin of the Arrangements of Leaves in Plants: Dr. Chauncey Wright.—A Continuation to a Catalogue of Maps of the British Possessions of India.—The Development of *Limulus polyphemus*: A. S. Packard.—On the Families of Fishes: E. D Cope.—Historical Notes on the Systems of Weather Telegraphy in the United States: C. Abbé.—The Cincinnati Medical News, Vol. i., No. 3.—The Indiana Journal of Medicine, Vol. ii., No. 2.—Medical Education in America: J. H. Bigelow.—Preliminary Report of the United States Geological Survey of Montana: Prof. Hayden.—Canadian Naturalist, Vol. vi., No. 3.—Report of the Chief Commissioner of Mines for the Province of Nova Scotia, 1871.—Acoustical Experiments: Alfred M. Mayer.

FOREIGN.—Ofversigt af konig. Vetenskaps Akad. Förhandlinger.—Anwendung der Darwinschen Lehre auf Bienen: H. Müller.—Memorie della Societa degli Spettroscopisti Italiani, 3 nos.—Bulletin de la Société d'Anthropologie de Paris, July and August, 1871.—Contributions to the Biology and History of the Development of the *Ustilagineæ*: Dr. A. Fischer von Waldheim.—La Belgique Horticole, March and April.—k. k. Akademie der Wissenschaften zu Wien, No. 7, 1872.—Académie Royale de Belgique, 1872.—Berichte der k. sächsischen Gesellschaft der Wissenschaften, July, 1871.—Notes sur des singes fossiles trouvés en Italie: C. J. Forsyth Major.

DIARY

THURSDAY, MAY 9.

SOCIETY OF ANTIQUARIES, at 8.30.—Inventories of Westminster, Waltham, and St. Albans: Rev. M. E. C. Walcott, F.S.A.

LONDON INSTITUTION, at 7.30.—On Solution and Supersaturation: C. Tomlinson, F.R.S.

MATHEMATICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 3.—On Heat and Light: Prof. Tyndall, F.R.S.

FRIDAY, MAY 10.

ASTRONOMICAL SOCIETY, at 8.

QUEKETT MICROSCOPICAL CLUB, at 8.

ROYAL INSTITUTION, at 9.—On Meteoric Stones: Nevil Story-Maskelyne.

SATURDAY, MAY 11.

ROYAL INSTITUTION, at 3.—The Star-Depths: R. A. Proctor.

GOVERNMENT SCHOOL OF MINES, at 8.—On Geology: Dr. Cobbold, F.R.S.

MONDAY, MAY 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

TUESDAY, MAY 14.

ROYAL INSTITUTION, at 3.—On the Development of Belief and Custom amongst the Lower Races of Mankind: E. B. Tylor, F.R.S.

PHOTOGRAPHIC SOCIETY, at 8.

WEDNESDAY, MAY 15.

SOCIETY OF ARTS, at 8.—On a New Mode of Utilising Sewage Precipitates: Major-General H. Y. D. Scott, C.B.

PHARMACEUTICAL SOCIETY, at 11 A.M.—Anniversary Meeting.

THURSDAY, MAY 16.

ROYAL SOCIETY, at 8.30.

SOCIETY OF ANTIQUARIES, at 8.30.

CHEMICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 3.—On Heat and Light: Prof. Tyndall, F.R.S.

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