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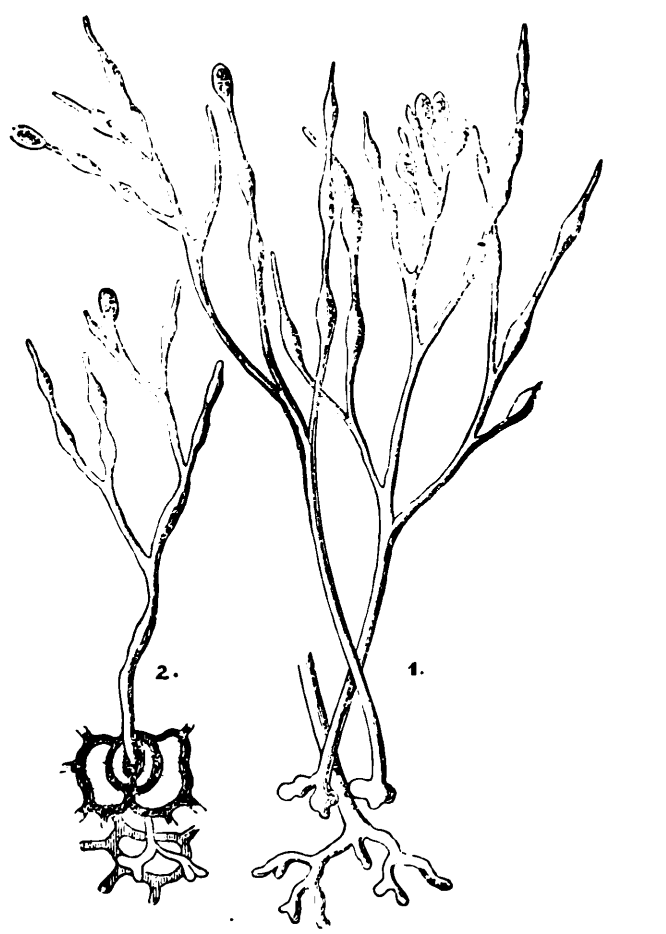
THURSDAY, SEPTEMBER 19, 1872

THE POTATO DISEASE

II.

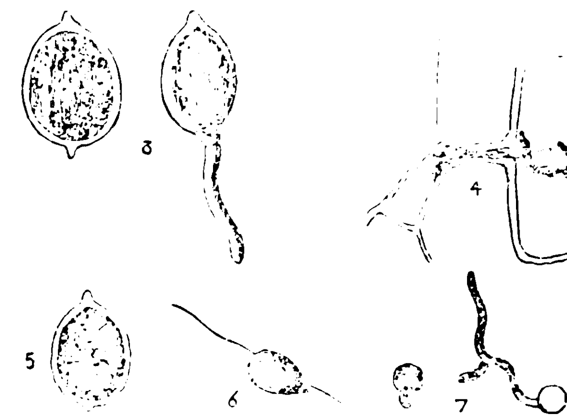
THE habits of the fungus which produces the potato disease, *Botrytis* or *Peronospora infestans*, have been closely investigated by Montagne, De Bary, and Berkeley. The latter gentleman has described its life-history in the *Gardener's Chronicle*, and the editor of that paper kindly permits us the use of the accompanying woodcuts, which illustrate Mr. Berkeley's paper. The fungus bears abundance of spores on the tips of the branches, the mycelium, or spawn, burrowing amongst the cellular tissue of the leaf and causing rapid decomposition, while the vertical threads which branch and bear the spores, find their way through the stomata, or leaf pores. The spores themselves, falling on different parts of the plant, germinate, and, penetrating the tissues, pro-



1. *Peronospora infestans.*
2. The same, burrowing among the tissues of the leaves, and making its way through the stomata.

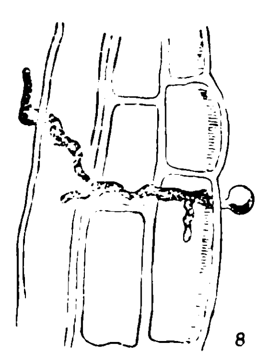
duce a brown tint, not only in the cells with which they are in immediate contact, but also in the adjacent cells. In addition to these spores, or, more correctly speaking, conidia, the fungus produces also zoospores, or moving spores, furnished with the well-known movable threads or processes, and which are differentiated from the contents of some of the ordinary spores. These bodies, like the ordinary spores, germinate and penetrate the tissues, producing the same brown tint, and in the same way as the kind already mentioned.

The fungus was unknown to the older mycologists, having, at all events, never attracted attention before the first great outbreak of the potato-blight in 1845. It is not quite peculiar to the potato, being found also occasionally on other plants belonging to the natural order Solanaceæ, especially on the fruit of the tomato. The first indication is the well-known brown spots on the leaves of the plants ; but by the time it manifests itself in this manner, its mycelium has already made deep inroads into the cellular tissue of the leaf and stem, and cure is well-nigh hopeless. The cutting-off of the haulm close to the ground will generally prevent the spread of the disease to the tubers, but this remedy is at the risk of destroying the quality of



3. Spores, or, more properly speaking, conidia, germinating.
4. The same, sown artificially, and penetrating the tissues after eighteen hours.
5. Spores with contents differentiated.
6. Zoospores.
7 Zoospores germinating.

the crop, since it is impossible for the tubers thoroughly to mature after the entire removal of the vegetative organs. The growth of the fungus is greatly promoted by wet weather, and the "sowing" over the crop of lime, which acts as a powerful desiccant, is therefore a natural remedy, as also is the application of soot, the properties of



8. Zoospores sown artificially in the stem, and after twenty-four hours penetrating the tissues and entering the intercellular spaces.

carbon as a disinfectant and absorbent of gases being so well known. Prof. Gardner states that the diseased tuber is strongly alkaline, from the presence of ammonia, the sound potato having an acid reaction. Since, also, we are commonly visited by heavy showers during the latter part of July and early part of August, the period when the disease generally first decidedly manifests itself, it is probable that the advice of the *Gardener's Chronicle* is sound, to plant chiefly early varieties, and lift early, though this will involve some loss to the productiveness of the crop. On all these points, however, we are greatly in want of the authoritative opinion of practical men, the result of a careful series of experiments from which all accidental causes have been eliminated. The Royal Horticultural Society has a fine opportunity of performing a most important service to practical agriculture by the institution of a series of crucial experiments in its experimental grounds at Chiswick.

Dr. Hooker's statement that the starch of the diseased potatoes is not affected by the parasite, but retains its nutritive properties, is worthy of more attention than it has yet received. He recommends rasping the peeled tubers upon a grater into a tub of cold water. In a few minutes the starch will be found to have sunk to the bottom, and the diseased matter, woody fibre, &c., will be suspended in the water, and should be poured away with it. Fresh water should then be added, the starch stirred up, and again allowed to settle. Two or three of such washings will remove all impurities, and render the starch fit for use. If thoroughly dried it will keep for any time, and can be used as arrowroot for puddings and cakes, and for mixing with flour as bread. This plan is open to obvious objections, both from its tediousness, and from the fact that when the disease has made any considerable progress, the smell is so offensive as to render both the peeling and the grating alike impossible to those possessed of ordinary olfactory perception. Dr Hooker, however, states that the plan was successfully pursued in 1845 and 1846 by the villagers of Hitcham under the direction of the late Rev. Prof. Henslow; and it seems incredible that chemical science should be unable to devise some practical and economical method for separating a wholesome substance of such enormous value in the bulk from the noxious ingredients.

Although the immediate cause of the potato disease has been clearly determined, as has been stated above, to be the attacks of a parasitic fungus, yet we are by no means prepared to agree with the conclusion of a distinguished writer,* that it "seems quite absurd, when the whole *rationale* of the potato disease has been so carefully explained, to look for an explanation in mere climatic conditions, exhaustion, weakness of constitution, or any of the empirical causes which are so often brought forward." The *Peronospora* is undoubtedly the proximate cause of the disease; for the ultimate cause we may have to look to a very different set of circumstances. It is probable that many epidemic diseases, both of men, animals, and plants, are caused by parasitic fungi; yet the attacks of the parasite may be favoured by special climatal or other conditions. We know that many animal plagues can be absolutely eradicated by the removal of the conditions which favour the propagation of the pest. The idea hinted at in our article last week that epidemic diseases may be expected in periodically recurring cycles is at least one deserving further investigation, and is supported by some curious facts. No reason has been given why the potato blight should have broken out so violently in 1845, when we had experienced before that many as ungenial summers during which it did not make its appearance, nor why it should have appeared simultaneously in so many remote countries—in St. Helena and Canada as virulently as in Europe—where the climatal conditions are altogether different; 1860 and 1872 are also not the only wet and thundery summers we have known during the last twenty years. It is quite possible that cosmical conditions may at definite intervals favour the disease, but that it may be developed only when certain other special conditions co-operate with these. We refer in another column to the systematic investigation now being carried on in France and Portugal as to the cause of the vine disease.

The period of maximum sun-spots of between eleven and twelve years, as shown by the researches of De La Rue, Stewart, and Loewy, falls in 1848, 1860, and 1872; and it is very singular that history seems to point to nearly the same approximate period for great national epidemics. Thus, according to Hecker's "Epidemics of the Middle Ages," the dates of the five great visitations of the sweating sickness in this country were 1485, 1506, 1517, 1528, and 1551, the epidemic being accompanied on almost every occasion by other pestilences in man and beast in this and other countries, or by general failure of crops. We have, of course, no means of ascertaining the condition of the surface of the sun during those years; but it is at least a singular coincidence that 29 cycles of 11·1 years bring us from 1551 to 1872.

We do not wish to lay more stress on these curious facts than they deserve, but simply to indicate the number of points of view from which the subject may be investigated. To have ascertained accurately the immediate cause of the potato disease is no doubt a great step gained; but the scientific method will not allow us to stop here. We must do our best to penetrate further into the arcana of Nature, and bring all the resources of Science to bear to investigate the conditions which appear to favour the appearance and spread of the invader, and the means which promise the greatest chance of success to repel his attacks.

* Rev. M. J. Berkeley, in *Gardener's Chronicle*, Nov. 4, 1871.

GLADSTONE'S LIFE OF FARADAY

Michael Faraday. By J. H. Gladstone, Ph.D., F.R.S., &c. (London: Macmillan and Co., 1872.)

THERE can be no doubt that a life of Faraday suitable for the general public was much needed. Dr. Bence Jones's work, though full of interest to scientific men, and to those who knew Faraday personally, was too voluminous and too lacking in cohesion to be very widely read. Dr. Tyndall's brilliant sketch fascinated the reader with the scientific aspect of the life it recorded, but left one longing to know "the inner supplement to that noble outward life" of Faraday. Dr. Gladstone's memoir very largely meets the wants we express.

There are few men better fitted to write a life of Faraday than Dr. Gladstone. Not only was he the personal friend of Faraday, associated with him in the management of the Royal Institution, and in scientific inquiries connected with the Trinity House, but, what is more important, their pursuits and sympathies ran in nearly parallel paths. And so with a loving hand Dr. Gladstone has gathered the materials for his memoir. These are drawn only to a small extent from sources with which we are already familiar, for the author gives us the benefit of his own recollections, and also numerous incidents from the many private sources of information to which he has had access. A delightful freshness and personal interest are thus given to the narrative. Here, for example, is an anecdote that will be new to most of our readers, and which illustrates the quiet humour which Faraday possessed One evening at the Royal Institution, when a lecture on the English language was being delivered, the lecturer mentioned as a common vulgarism the habit of using "don't" in the third person singular, and cited, as an instance, "He don't pay his debts." Faraday, who was sitting in his usual place to the right of the lecturer, immediately exclaimed aloud, "That's very wrong!"

A very striking story was related to Dr. Gladstone by Cyrus Field. It is a sequel to the very circumstance that Dr. Tyndall has chosen as an example of Faraday's wonderful insight into nature, so like "a divining power." When Mr. Field was making the preliminary arrangements for that great enterprise with which his name will always be associated, he sought Faraday's advice on the electrical questions involved in a transatlantic cable. Faraday told him that he doubted the possibility of getting a message across the Atlantic. Mr. Field saw that this fatal objection must be settled at once, and begged Faraday to make the necessary experiments, offering to pay him properly for his services. The philosopher, however, declined all remuneration, but worked away at the question, and presently reported to Mr. Field—"It can be done, but you will not get an instantaneous message." "How long will it take?" was the next inquiry. "Oh! perhaps a second." "Well, that's quick enough for me," was the conclusion of the American; and the enterprise was proceeded with. This is an important incident, for not only does it show the readiness with which Faraday, when appealed to, freely lent himself to aid any scientific work, but it also indicates the confidence with which he applied the results of the laboratory to the grandest practical operations.

There are many other parts of Dr. Gladstone's memoir that we have marked for quotation, but our space will not allow us to do justice to the book by extracts. With pleasure we refer our readers to the volume itself, which is distinguished throughout by the modesty and self-forgetfulness of its author, its earnest tone, and the entire absence of all technicalities.

Dr. Gladstone will, however, permit us to indulge in a little friendly criticism on the arrangement of his materials. The memoir is divided into five parts—first, "the story of Faraday's life" is told us; then comes a "study of his character;" after which we have "the fruits of his experience," followed by "his method of working;" and in the last section we are shown "the value of his discoveries." With all deference to the reasons—no doubt well considered—which induced Dr. Gladstone to arrange his memoir thus, we venture to think that such a division is inartistic, and at first sight apt to repel a thoughtful mind. For is it not a slight upon the intelligence of his readers if an author presumes they cannot draw the study of a man's character nor "the fruits of his experience" from "the story of his life." Moreover, after having read the first part, which every one must agree is admirably done, we come upon a collection of incidents in Faraday's life, and anecdotes illustrating his character, that lose much of their force, by being massed together for a predetermined effect. It is the very spontaneousness and unobtrusiveness of the words and actions of a noble character that constitute their real claim to our admiration. And therefore we think it would have been far better if the author had woven into the life of Faraday the numerous incidents he has collected, rather than have let them lose their charm by a process of classification.

But if the arrangement is, in our humble opinion, not quite perfect, it certainly is the only blemish we can find in the work. It is a biography that will be read with interest by every intelligent person, and can be thoroughly enjoyed by those who are quite ignorant of science. It is a capital book for the youth of the present day, and among many of them we trust it will arouse a noble enthusiasm.

Now let us turn from the book to the man. Our readers do not need us to remind them of the history of Faraday, a history, which viewed in the grand achievements of his life, is so simple as to be almost sublime. Everyone knows that from a bookbinder's apprentice he lifted himself to the highest position in the scientific world. Here we may remark that we doubt whether a truly heroic nature has ever been quite covered up by the crowd of humanity. A great soul is a hero anywhere, and will win the recognition and often the worship of mankind, in spite of every obstacle. Faraday was an example of this. For the first twenty years of his life who knew him? What was his residence but a mere number in a back street? But before his death who did *not* know him? Every scientific society had laid a tribute of admiration at his feet, and he received letters inscribed to "Professor Faraday, member of all Academies of Science, London."

As his fame grew, and it became possible for him to make his name profitable, and realise thereby a considerable fortune, he permitted no selfish consideration to influence his career. Promptly rejecting that income which came from the sacrifice of his investigations, he obeyed the voice that said to him, "*Wisdom* is the principal thing, therefore get wisdom." So for fifty years one lofty idea animated his thoughts and sustained his indefatigable labour. His life became the ideas of what a philosopher's life should be, written only in the imperishable work he has done. Accepting no reward for his labours, declining any title or elevation of rank, seeking no public applause, living and dying in retirement and comparative poverty, Faraday consecrated himself to his work, and freely left to the world the magnificent revelations of a genius devoted to Nature. This surely is the life of a hero: noble devotion combined with utter unselfishness, the characteristics of a Cromwell, a Bruce, or a Garibaldi.

Though Faraday lived in retirement, and spent most of his hours in the laboratory, few men have passed a happier lifetime. No doubt the orderly and sustained simplicity of his daily life was one cause of the perpetual gladness of his heart. He confined his thoughts chiefly to his work and his home, and he regulated his life in the most methodical and natural manner. This may be seen from a little incident mentioned to the writer by Mr. Faraday's early friend, the late Mr. Benjamin Abbott. Some thirty years ago Mr. Abbott called to see Mr. Faraday, whom he had not met for many years. On inquiring at the Royal Institution the hall-porter told him that Mr. Faraday was at work, and could not be seen by anyone, indeed, that he dare not even take a visitor's card down to him. On Mr. Abbott's explaining that he was an old friend, the hall-porter suggested, with an obliging politeness which is conspicuous there still, that, as it was near one o'clock, Anderson (Faraday's faithful assistant) would soon be going to his dinner, when probably he might catch sight of Mr. Faraday coming upstairs. Mr. Abbott waited; punctually at one Anderson emerged from the laboratory, Mr. Faraday followed, and, recognising his old friend at once, begged him to join them at dinner. "For," added Faraday, "I am a Goth you know, and always dine in the middle of the day." At dinner Faraday told Mr. Abbott a characteristic story about Anderson; how one morning during his glass experiments he found his assistant had been stoking the furnace all night long. Faraday had told him to keep the fire up, and omitting to release him in the evening, Anderson, with his soldier's excellent experience, stuck to his post till he received the next orders from his master. The fact that this simple obedience was all the assistance Faraday ever had increases the astonishment with which one regards the extent of his labours. The secret of the massiveness of Faraday's work was no doubt that he felt he had *one* aim before him, and therefore he rigidly kept from himself everything that would fritter away his time; political and commercial matters were passed by; he had his warfare to accomplish, and "no man that warreth entangleth himself with the affairs of this life."

Whilst Faraday found it necessary to shut out society, he enjoyed a social gathering, especially a family of children, whom he would amuse by dexterous experiments in glass-blowing, or with other less scientific manipulation. He liked occasionally to take his nephews to the pantomime, himself enjoying, as he said, "the immense concentration of means which it requires." Or he would attend in his early days, as Dr. Gladstone tells us, "the artistic and musical conversaziones at Hullmandel's, where Stanfield, Turner, and Landseer met Garcia and Malibran; and sometimes he would join this pleasant company at supper and charades, at others in their excursions up the river in an eight-oared cutter."

His delight in giving others pleasure showed itself continually. He was considerate and courteous to the lowest servant at the Royal Institution. The writer can testify to the enduring impression made by his words of kind encouragement and acts of thoughtful friendship towards the assistants in the laboratory. As Dr. Bence Jones well remarks, his humility had a living root in his religion. Of the intense earnestness of the religious aspect of his nature, it does not become us here to speak; he did not talk, but he lived Christianity. He rose above his peculiar creed. In no sense contracted or censorious, he shed a warm radiance on all with whom he came into contact. It was impossible to dwell in his presence without feeling all that was best in one's nature rising to the surface. Most tender and touching were the words he addressed to sorrowing friends. What a depth of affection is revealed by the following letter, written to a lady who had recently lost her husband:—

"Believe that I sympathise with you most deeply, for I enjoy in my life-partner those things which you speak of as making you feel your loss so heavily.

"It is the kindly domestic affections, the worthiness, the mutual aid in sorrow, the mutual joy in happiness which has existed, which makes the rupture of such a tie as yours so heavy to bear; and yet you would not wish it otherwise, for the remembrance of those things brings solace with the grief. I speak, thinking what my own trouble would be if I lost my partner, and I try to comfort you in the only way in which I think I could be comforted."

We are reminded by this and other letters of Faraday, that the inner life of a man is best seen in the letters to his intimate friends never meant for publication. In Faraday's exquisite letters, exquisite because so utterly artless, are revealed the happy, loving spirit, and, as Mr. Ruskin would say, the "*fineness of nature*" he possessed.

Another striking characteristic of Faraday was the quiet and unostentatious manner in which he did everything. His style of lecturing was so simple and easy as to appear effortless. This apparent absence of effort is, however, the climax of self-culture. A man only does that perfectly well which he does without the evidence of exertion. Faraday had reached this point through the mental discipline to which he habitually subjected himself. He translated into practice the words in which he expresses his own "strong belief that that point of self-education which consists in teaching the mind to resist its desires and inclinations until they are proved to be right, is the most important of all, not only in affairs of natural philosophy, but in every department of life."

With all this stern reality there was also a fine poetic fancy in Faraday. To him the Universe was no machine. His was "a face-to-face, heart-to-heart, inspection of things," and this, as Carlyle says, is "the first characteristic of all good thought in all times." Scientific phraseology never hid from him the grandeur and mystery that at bottom lies in everything. A thunder-storm was to him no mere affair of positive and negative electricity, no mere discharge of electric potential, but something infinitely beyond all this—"a window through which he looked into Infinitude itself." Dr. Gladstone tells us "he would stand gazing at the lightning, a stranger to fear, with his mind full of lofty thoughts, or perhaps of high communings. Sometimes, too, if the storm were at a little distance, he would summon a cab, and in spite of the pelting rain, drive to the scene of awful beauty." A friend thus met him once at Eastbourne, "in the thick of a tremendous storm, rubbing his hands with delight because he had been fortunate enough to see the lightning strike the church tower."

We are told that a new fact "seemed to charge him with an energy that gleamed through his eyes and quivered through his limbs." The writer remembers an illustration of this, when Dr. Tyndall brought Mr. Faraday into the laboratory to look at his new discovery of calorescence. As Faraday saw for the first time a piece of cold, black platinum raised to a dazzling brightness when held in the focus of dark rays, a point undistinguishable from the air around, he looked on attentively, putting on his spectacles to observe more carefully, then ascertained the conditions of the experiment, and repeated it for himself; and now quite satisfied he turned with emotion to Dr. Tyndall and almost hugged him with pleasure. And so on another occasion, when Prof. Plücker was showing in the laboratory some lovely experiments with vacuum tubes, Faraday literally danced with delight round the electric discharge, exclaiming, as he gazed at the moving arches of light, "Oh! to live always in it!"

We have said enough. Our readers will forgive us for recalling a character which many of them know far better than the writer. But we are never tired of contemplating a nature so singularly beautiful as that of Faraday. Whether we think of him as pourtrayed by Dr. Bence Jones, Dr. Tyndall, or Dr. Gladstone, or by Prof. Helmholtz, Dumas, or De la Rive, the picture is still the same ;—

"His life was gentle ; and the elements
So mix'd in him, that Nature might stand up
And say to all the world, 'This was a Man!'"

W. F. BARRETT

LETTERS TO THE EDITOR

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

American Stone Arrowheads

I AM glad to perceive that Dr. Abbott has called attention to the variations in form among North American stone arrowheads, although he cannot admit the correctness of some of the remarks I have incidentally made on this subject in my "Ancient Stone Implements of Great Britain." At the time when that work went to press, I was not in possession of Dr. Abbott's "Stone Age in New Jersey," if, indeed, it had appeared, and in describing the various North American forms, for want of other authorities I principally referred to Schoolcraft, Squier and Davis, and Prof. Daniel Wilson, some of whom Dr. Abbott appears to consider as somewhat antiquated.

It is not to be supposed that my acquaintance with the collections in the United States should in any way approach that of Dr. Abbott, as I have never visited America. My views as to the prevalence of different types were, however, mainly founded, not on printed descriptions, but on actual specimens preserved in collections in this country, my own among the number ; and with all deference to Dr. Abbott, who has kindly promised to send me the specimens on which he bases his remarks, I think it will be found that his views, even if completely applicable to New Jersey, will hardly hold good throughout the northern part of the United States and Canada. The principal points on which he disagrees with me are—

1. As to the arrowheads with a notch at the base on either side constituting a prevailing type in North America.
2. As to the leaf-shaped form being very rare.
3. As to the chipping being for the most part but rough, as compared with that exhibited on the arrowheads found in Britain.

1. As to the first point, Dr. Abbott does not appear to appreciate the difference between "a" and "the;" and though it is possible that other forms of arrowheads are found in America in equal numbers with those such as I have mentioned, yet I think he would agree with me, if he were comparing a series, from North America with one from some other country, in recognising those with a notch at the base on either side as offering one of the prevailing types.

2. As to the leaf-shaped form being very rare, I may observe that among the thirty-eight figures of arrowheads given by Dr. Abbott in his "Stone Age in New Jersey" only one is leaf-shaped, though he mentions the plain leaf-shaped form as the prevailing variety of the leaf-shaped arrowhead and its modifications. In my own collection, comprising upwards of 160 North American arrowheads, there are only six that can be termed leaf-shaped, and but two of these are really typical specimens of the form. These two have come into my possession since my book was written. If not "very rare" I think the form must be regarded as comparatively rare.

3. Lastly, as regards workmanship, Dr. Abbott seems not to have observed that my statement as to the roughness of chipping was qualified with the words "for the most part." Anyone comparing a collection of stone arrowheads from North America with one formed in Britain or Ireland would, I think, at once admit that, as a whole, the latter were more finely and delicately chipped. Or, again, comparing Dr. Abbott's illustrations with mine the same general conclusion will be attained. Even the most elegantly formed American specimens that I have seen cannot compete in delicacy of workmanship with some of the English examples, such, for instance, as those represented in my Figures 317, 318, 319. I can only say that if Dr. Abbott or any other American collector will kindly send me some specimens equally well-chipped, I shall be proud to add them to my collection, and not too proud to acknowledge any errors into which I may have been betrayed through insufficiency of knowledge.

JOHN EVANS

Nash Mills, Hemel Hempsted, Sept. 14

Botanical Terminology

BOTANY is now being taught to large numbers in public and middle-class schools ; its admission as a subject of general study can only be justified by its high educational value, not so much as an end, but as a means. Many of the boys who work at it will have no time to continue the study in detail, and the little they know of it will be what they learn at school.

Upon all these grounds it is desirable that there should be no unnecessary or conventional impediments placed in the way or as much education as possible being given in the short time allotted to it. I am desirous of eliciting an opinion as to whether the botanical terminology is or is not an impediment, diminishing the educational value and restricting the scope of the subject. For some years at Rugby I have felt myself hampered with a weariness of names. Is a terminology as polyglot in its derivation as the tower of Babel, and often involving questionable hypotheses of function, or incorrect ideas of morphology, the best instrument for making young pupils observe accurately or reason accurately on observed results? And yet a teacher cannot select the terms he will use, (1) because the books, and especially the English and local floras, imply in their readers a knowledge of a wide terminology ; and (2) because, as in the fight against Euclid, so here the teacher is subject to the examiner, and at present the examination papers of the Science and Art Department, Cambridge Local, &c., are incomprehensible to a boy not bristling with terms.

Allow me specially to call attention to some of what appear to me unnecessary faults in the terms used, and to suggest one or two remedies. The names chosen to denote parts are mainly derived from Latin or Greek, or both, or have no received derivation. Well, even supposing that the words do, by their derivation from the dead language, suggest to those who know it some clue to their meaning, yet how few boys can keep these derivations in their heads, especially in schools in which Latin is not much and Greek not at all taught. Why on earth, when the promoters of science are driving out Greek to let in science, should a knowledge of Greek be a necessary "open sesame" to the correct remembering and spelling of botanical terms?

But the above supposition is seldom correct, the words when translated expressing either a fanciful resemblance, or some pre-adamite stage of botanical knowledge. If the opening through which the pollen-tube passes is already called "little gate," perhaps we must submit to the name, but why call it "micropyle."?

And here perhaps is the place to make a protest against such words as were flooded into the science at the time when the sexuality of plants was first established.

The usefulness of insisting on the generalisation that gamogenesis was common to plants and animals only exists in teaching those who know what gamogenesis in animals means. Does that usefulness exist in the case of boys and girls who learn botany.? In teaching Human Physiology, some subjects are omitted and rightly omitted, from such text-books as Huxley's Elementary Physiology ; why then should a knowledge of such subjects be assumed in our botanical terms? The facts of botany can all be taught, as far as my experience of boys and girls goes, without the slightest difficulty; the generalisation will follow of itself, as soon as it is wanted ; I only object to its being gratuitously, and almost pruriently, forced on the attention. Who can approve of the use in our elementary floras of the term "hermaphrodite," or the same symbols for pistillate and staminate plants being used which the boys are taught in their astronomy as the recognised symbols for Venus and Mars? To this class belong the tribe of words ending in *—androus* and *—gynous*, which must either be taught as unintelligible gibberish, or explained on gamogenetic analogy. I do not wish to be misunderstood: if you are teaching the physiological subjects in animals, let "honi soit" be your motto, and call a spade a spade ; there are worse evils than we dream of arising from obscurantism ; but if you are teaching botany, keep to your subject, and do not go out of your way to call a club a spade.

Lastly, many words are utterly confusing: either they seem by their jingling similarity to make the learner and indeed even older botanists sure to confuse them, as *loculicidal* and *septicidal* and the troop of words which end in —*tropous*; or they convey a morphologically impossible idea, as *inferior* and *superior* as applied to the ovary. To see how these faults can be avoided, let us inquire why an unusual amount of names are required at all.

(I.) Popular names being vaguely used require to be restricted in their meaning by accurate definition.

(II.) A new name is required for any part to which no name is popularly assigned, either because the thing to be named escapes popular observation, or because two or more things are included in the connotation of the popular term.

(III.) New adjectives, or adjectival-periphrases, are required to express characteristics, or relations of part to part.

Let me briefly suggest some principles, which, while remedying the faults of the old terminology, seem not to clash with these three necessities of the subject.

(*a*) Names for new things to be given in English, *ex. gr.*, the names *calyx* and *corolla* to be taught as *cup* and *crown*: in this we should be only following the German use of Kelch and Krone.

(*b*) Where a part of a thing already named requires a fresh name, the preference to be given to a name framed like the German double words—Kelch-blatt, Staub-blatt—so as to indicate the relation of part to part, thus *cup-leaf*, *leaf-stalk*, *flower-stalk* to be taught instead of *sepal*, *petiole*, and *peduncle*.

(*c*) Short expressions involving English (not Greek) prepositions to be used for adjectives: thus *splitting by mid-ribs*, *on seed-vessel*, *united by dust-pouches*, to be used for *loculicidal*, *epigynous*, *syngenesious*.

(*d*) Where the definitions of the terms is given in numbers, numbers or fractions be used instead of those terms: thus in æstivation, ⅖ to be used for quincuncial; in cutting of leaves the fraction of the leaf cut to be stated instead of *omnia quæ exeunt*, *in-fid*, *-sect*, and *-partite*.

But it will be said—how will pupils taught thus get on afterwards? The answer is, either they will do no more of the subject than they do at school, in which case they will have got the idea without the obstructions of the terms; or they will care to go on further with the subject, in which case they will learn the terms very quickly, being now familiar with the facts and ideas. In neither case will time have been lost, and the scope of botanical subjects which may be treated in the time will have been doubled.

I must apologise for the length to which this letter has run.

FRANK E. KITCHENER

Rugby, September 16

Hutton's Trigonometrical Tables, for Arcs expressed as portions of the Radius

AT the end of the preface of the first edition of Hutton's Mathematical Tables (1785) is the following postscript:—"P.S.—Since my History of Trigonometrical Tables in the following Introduction was printed, there has been published in the 'Philosophical Transactions' for the year 1784, a paper of mine concerning a project for the trigonometrical tables to be constructed on a new plan, namely, in which the arc of the quadrant is divided into aliquot parts of the radius, or according to the real lengths of the arcs, which construction is now in some degree of forwardness, as myself and several assistants have been closely engaged in the execution of it ever since." And in the succeeding editions, down to the sixth, 1822, there occurs on p. 2 of the Introduction the following remark:—"But the complete reformation would be to express all arcs by their real lengths, namely, in equal parts of the radius decimally divided, according to which method I have nearly completed a table of sines and tangents." Hutton died in 1823, and I can find no further reference to the table in question. I feel pretty certain that it has never been published, and there is no other paper on the same subject (except that in the Phil. Trans., 1784) of Hutton's referred to in Watt's "Bibliotheca" or the Royal Society's Catalogue.

The table was intended to give the sines, tangents, &c., of $\frac{1}{1000000}$, $\frac{2}{1000000}$, &c. (the unit being the arc equal to radius) to seven decimal places, and would be very useful. If it has not been published, perhaps some reader of NATURE might be able to say what has become of the manuscript that was nearly completed.

I may mention that the calculation of such a table was under the consideration of the Tables Committee of the British Association, but it was thought that some other tables were at present more urgently needed.

J. W. L. GLAISHER

Cambridge, Sept. 16

THE "HASSLER" EXPEDITION

WE are indebted to the courtesy of the Editor of the *New York Tribune* for early communication of the following information from Prof. Agassiz's expedition:—

OFF GUATEMALA, July 29, 1872

To Prof. Benjamin Peirce, Superintendent U.S. Coast Survey.

MY DEAR PEIRCE:—Do not be surprised at my few messages. It is about all I can do to take advantage of every opportunity that offers for study and collecting; but I rarely feel sufficiently collected to do any connected writing. I have another new chapter concerning glacial phenomena, gathered during our land journey from Talcahuano to Santiago, but it is so complicated a story that I do not feel equal now to recording the details in a connected statement, while the whole may be put in a few words.

There is a broad valley between the Andes and the coast range, the Valley of Chillan extending from the Gulf of Ancud, or Port Montt, to Santiago, and farther north. This valley is a continuation, upon somewhat higher level, of the channels which, from the Strait of Magellan to Chiloe, separate the islands from the main land, with the sole interruption of Tres Montes, which gives the clue to the whole, as we have here in miniature a valley between the Andes and the coast range. Now this great valley, extending for more than 25 degrees of latitude, is a continuous glacier bottom, showing plainly that for its whole length the great southern ice-sheet has been moving northwards in it. I could find nowhere any indication that glaciers descending from the Andes had crossed this valley and reached the shores of the Pacific. In a few localities only did I notice Andean, *i.e.*, volcanic erratics upon the loose materials filling the old glacier bottom. Between Currillo and Santiago, however, facing the gorge of Tenon, I saw two distinct lateral moraines, parallel to one another, chiefly composed of volcanic boulders, resting upon the old drift, and indicating by their position the course of a large glacier that once poured down from the Andes of Tenon, and crossed the main valley, without, however, extending beyond the eastern slope of the coast range. These moraines are so well marked that they are known throughout the country as the Cerillos of Tenon; but nobody suspects their glacial origin; even the geologists of Santiago assign a volcanic origin to them.

What is difficult to describe in this history are the successive retrograde steps of the great southern ice-field, that, step by step, left to the north of it larger or smaller tracks of the valley free of ice, so that large glacial lakes could be formed, and, in fact, seem always to have existed along the retreating edge of the great southern glacier. The natural consequence is that there are everywhere stratified terraces, without border barriers (as these were formerly the ice that has vanished), resting at successively higher or lower levels, as you move north or south, upon unstratified drift of older date, the northermost end of these terraces being the oldest, while those farther south belong to the latter steps in the waning of the ice-fields. From these data I infer that my suggestion concerning the trend of the striæ upon the polished and glaciated surfaces of the vicinity of Talcahuano, alluded to in the postcript of my last letter, is probably correct.

I was much grieved on reaching Valparaiso to hear of the mishaps of the dredging apparatus. The subsequent departure of Pourtales has been a great loss to us all, for notwithstanding his silent nature, he is a powerful standby.

Our visit to the Galapagos has been full of geological and zoological interest. It is exceedingly impressive to see an extensive archipelago, of most recent origin, inhabited by creatures so different from any known in other parts of the world. Here we have a positive limit to the length of time that may be granted for the transformation of these animals, if they are in any way derived from others dwelling in different parts of the world. The Galapagos are so recent that some of these islands are barely covered with the most scanty vegetation, itself peculiar to these islands; some parts of their surface are entirely bare, and a great many of the craters and lava streams are so fresh that the atmospheric agents have not yet made an impression upon them. Their agent does not, therefore, go back to earlier geological periods; they belong to our time, geologically speaking. Whence then do their inhabitants come from—animals as well as plants? If descended from some other type, belonging to some neighbouring land, then it does not require such unspeakably long periods for the transformation of species as the modern advocates of transmutation claim; and the mystery of change, with such marked and characteristic differences between existing species, is only increased and brought to a level with that of creation. If they are autochthones, from what germs did they start into existence? I think that careful observers, in view of these facts, will have to acknowledge that our science is not yet ripe for a fair discussion of the origin of organised beings.

Our stay in Panama has allowed us to make very extensive collections in the Bay and across the Isthmus. I was surprised to find so little difference in the character of the flora and of the terrestrial fauna between the two oceans. Marked peculiarities are only to be found among the marine animals, and even among them the American character of the Atlantic and Pacific marine fauna is unmistakable; we are not surrounded by animals recalling by their peculiarities the many groups of islands of the Pacific. I expect that our visit in Acapulco will confirm these impressions. L. AGASSIZ

CAPTAIN HALL'S ARCTIC EXPEDITION

THE *Washington Chronicle* of August 26 contains the following interesting account of the progress and position of this important expedition:—"The Navy Department has received later despatches from Captain Hall, by the way of Tydskland and Copenhagen, completing his official record up to the moment of final departure from North Greenland. These despatches, which are quite full, bear date off Tossak, Tussuissuk, N. lat. 73° 21′, W. long. 56° 5′, August 24, 1871, and are, therefore, only four days later than Hall's Upper Navik despatch, August 20, 1871, which reached the department within three months by the way of Copenhagen. The explanation of this long delay *in transitu* is that there is no regular communication between Denmark and these far-off colonies but once a year. Hall's Upper Navik despatches were timed to reach the Danish brig just then sailing, and this present letter sent back by native pilots, as he notes in concluding, may have had near a year's detention in Disco. It seems to have reached the American Minister at Copenhagen about July 30. Although thus divested of any special value as news, the present despatch is of much intrinsic interest. All on board the *Polaris*, officers, scientific corps, and men, were well and in excellent spirits. The seagoing qualities of the vessel had been tested and found admirable; the engines and machinery were in perfect working order, coal and rosin in good supply, and the ship's crew abundantly provisioned. For the long Arctic night before them they had books, games, instrumental music, &c.—in a word, everything that the thoughtful care of the department could supply, or letters of credit at Newfoundland and in Greenland furnish, had been laid in to complete their outfit, and of all this Captain Hall makes characteristic and thankful acknowledgments. Governor Elberg, of the Navik district, had accompanied the *Polaris* as far as Tossak, the extremest northerly limits of Danish jurisdiction as well as of civilised life, and was to the last moment assiduous in his exertions to further the interests of the expedition. Mainly through his co-operation Hall was fortunate enough at Tossak to make up his complement of Esquimaux dogs—sixty strong, healthy animals—a matter of almost vital importance. He likewise laid in a large supply of dog food, and considerably augmented his stock of reindeer-furs, sealskins, &c., for the adventurous voyage. At Upper Navik the expedition had shipped Hans Christian, a famous native hunter and dog-driver, with his wife and three children. Jensen, the Dane, who was under promise to join the expedition at Tossak, backed out at the last moment. Governor Elberg, of whose many kindnesses Hall speaks with full heart, awaited at Tossak the return of the native pilots, bearing this despatch to him, and it closes with the prow of the *Polaris* northward in the early morning of August 24, with a complete roster of all on board, thirty-three souls, and a fervent, hopeful prayer for success. It will be remembered that Captain Hall's previous despatches speak of his good fortune in meeting at Holsteinburg the returning Swedish expedition, and that the commander, Baron van Otter, kindly furnished him copies of log, deep-sea soundings, &c., assuring him that the season was more than usually favourable, and extremely wide iceberg-channels, &c. Of the same purport was the information received of Governor Rodolph, thirty years resident in North Greenland, who declared the year to be more favourable for any northern voyage than many years agone or to come. Acting on this information, and under discretionary power vested in him by the Navy Department, Captain Hall had abandoned the Jones's Sound route, and had decided before he left Upper Navik that after stopping at Tossak he would cross Melville Bay to Cape Dudley Digges, and from that point steam direct to Smith's Sound, thence make all possible attempts to find a passage on the west side of the Sound from Cape Isabella up to Kennedy Channels, wintering there probably in about the same latitude or a little higher than Kane's winter quarters, and thence on and up to the North Pole. The letter published in the *New York Times*, April 25, purporting to narrate a disaster to the *Polaris* and her return last February to Disco, was a *canard*. Not one word of it has ever been credited at the Navy Department. It is not believed that any disaster has overtaken the Expedition, or that any ground for apprehension exists."

*THE BLIND FISHES OF THE MAMMOTH CAVE AND THEIR ALLIES**

THE *Amblyopsis spelæus* undoubtedly has quite an extensive distribution, probably existing in all the subterranean rivers that flow through the great limestone region underlying the Carboniferous rocks in the central portion of the United States. Prof. Cope obtained specimens from the Wyandotte Cave and from wells in its vicinity, and in the Museum of Comparative Zoology at Cambridge there is a specimen labelled "from a well near Lost River, Orange Co., Ind.," which, with those from the Wyandotte Cave, is conclusive evidence of its being found on the northern side of the Ohio† as well as on the southern, in the rivers of the Mammoth Cave. I have been able to examine a number of specimens from the Mammoth Cave, and have carefully compared with them the one from the well in Orange Co., Ind., and find that the specific characters are remarkably constant.

* Reprinted from the *American Naturalist*, a sequel to "The Blind Crustacea of the Mammoth Cave." See NATURE, vol. v. pp. 445, 484.

† I have also been informed by Mr Holmes of Lansing, Mich., that *blind fishes* have been drawn out of wells in Michigan.

In 1859* Dr. Girard described a blind fish, received by the Smithsonian Institution from J. E. Younglove, Esq., who obtained it "from a well near Bowling Green, Ky." The general appearance of this fish, which was only one and a half inch in length, was that of *Amblyopsis spelæus*, but it differed from that species in several characters, especially by the *absence* of ventral fins. Dr. Girard therefore referred the fish to a distinct genus under the name of *Typhlichthys*† *subterraneus*. Dr. Günther‡ considers this fish a variety of *Amblyopsis spelæus*, and records the specimen in the British Museum "from the Mammoth Cave," as half-grown.§

By the kindness of Prof. Agassiz, I have been enabled to examine nine specimens of *blind fish without ventrals*, in the Museum of Comparative Zoology. Seven of these were collected in the Mammoth Cave by Mr. Alpheus Hyatt, in September 1859. One was from Moulton, Lawrence County, Alabama, presented by Mr. Thomas Peters; and another from Lebanon, Wilson Co., Tennessee, presented by Mr. J. M. Safford. It is not stated whether these latter came from wells or caves, but probably from wells. They are all of about one size, one and one-half to two inches in length, and are constant in their characters. Moreover, four of the seven specimens from the Mammoth Cave were females with eggs. These eggs were as large in proportion as those from *Amblyopsis*. The ovary was single, and situated on the right side of the stomach, as in *Amblyopsis*. The difference in the number of eggs was very remarkable, each of the four specimens examined having but about thirty eggs in the ovary, while in three females of *Amblyopsis* (all, however, of nearly three times the size of *Typhlichthys*) there were about one hundred eggs in each. As in both species there were no signs of the embryos in the eggs, it is not probable that any of the eggs had been developed and the young excluded, nor is it at all likely that the great variation in the number of eggs would simply indicate different ages. For these reasons, taken in connection with the absence of ventral fins, I have no hesitation in accepting Dr. Girard's name as valid for this genus, of which we thus far know of but one species, with a subterranean range from the waters of the Mammoth Cave, south, to the northern portion of Alabama. In this connection it would be most interesting to know the relations of the "blind fishes" said to have been found in Michigan. For thus far we have *Typhlichthys* limited to the central and southern portion of the subterranean region, *Amblyopsis* to the central, and the species in the northern portion undetermined.

In 1853, on his return from a tour through the southern and western states, Prof. Agassiz gave a summary of some of his ichthyological discoveries in a letter to Prof. J. D. Dana.‖ In this letter are the following remarks:—

"I would mention foremost a new genus which I shall call *Chologaster*, very similar in general appearance to the blind fish of the Mammoth Cave, though provided with eyes; it has, like *Amblyopsis*, the anal aperture far advanced under the throat, but is entirely deprived of ventral fins; a very strange and unexpected combination of characters. I know but one species, *Ch. cornutus* Ag. It is a small fish scarcely three inches long, living in the ditches of the rice fields in South Carolina. I derive its specific name from the singular form of the snout, which has two horn-like projections above."

This is the only information ever published regarding this interesting fish, and the only specimens known are those on which Prof. Agassiz based the above remarks.

The only specimen known of this second species was drawn from a well in Lebanon, Tenn., and presented to the Museum by Mr. J. M. Safford, Jan. 1854. It is a more slender fish than *C. cornutus*, but the intestine follows the same course, and the four pyloric appendages are present as in that species.

In the genus *Chologaster*† we have all the family characters as well expressed as in the blind species, though it differs from *Amblyopsis* and *Typhlichthys* by the presence of eyes, the absence of papillary ridges on the head and body, and by the longer intestine and double the number of pyloric appendages, as well as by the position of the ovary; and agrees with *Typhlichthys* by the absence of ventral fins. *Amblyopsis* and *Typhlichthys* are nearly colourless, while *Chologaster Agassizii* is of a brownish colour, similar to many of the minnows, and *C. cornutus* is brownish yellow, with dark, longitudinal bands.

Among the most interesting points in the history of this genus is the fact of its occurring in two widely different localities, *C. Agassizii* having been found in a well in the same vicinity (probably in the same well) with a specimen of *Typhlichthys*, and undoubtedly belonging to the same subterranean fauna west of the Appalachian ridge, while *C. cornutus* belongs to the southern coast fauna of the eastern side of that mountain chain, and is thus far the only species of the family known beyond the limits of the great subterranean region of the United States.

Having now given an outline of the structure, habits, and distribution of the four species belonging to the family and recapitulated the known facts, we are better able to consider the bearings of the peculiar adaptation of the blind fishes, in the Mammoth and other caves, to the circumstances under which they exist.

Prof. Cope, in stating, in his account of the blind fish of the Wyandotte Cave, "that the projecting under jaw and upward direction of the mouth renders it easy for the fish to feed at the surface of the water, where it must obtain much of its food," suggests that:—

"This structure also probably explains the fact of its being the sole representative of the fishes in subterranean waters. No doubt many other forms were carried into the caverns since the waters first found their way there, but most of them were like those of our present rivers, deep water or bottom feeders. Such fishes would starve in a cave river, where much of the food is carried to them on the surface of the stream. . . . . . The shore minnows are their nearest allies, and many of them have the upturned mouth and flat head. . . . . . Fishes of this, or a similar family, enclosed in subterranean waters years ago, would be more likely to live than those of the other, and the darkness would be very apt to be the cause of the atrophy of the organs of sight seen in the *Amblyopsis*."

This suggestion was undoubtedly hastily made by Prof. Cope when writing the letter which was printed in the *Indianapolis Journal*, and were it not that the article has been reprinted in the "Annals and Magazine of Natural History," I should not criticise the statement made in an off-hand letter for publication in a newspaper; for with Prof. Cope's knowledge of fishes it could simply be a hasty thought which he put on paper, when he suggests that it is because the *Cyprinodontes* have a mouth directed upwards and are surface feeders that they were better adapted to a subterranean life than other fishes, and hence maintained an existence, while other species, which he supposes were introduced into the subterranean streams at the same time, died out.

If the fishes of the subterranean streams came from adjoining rivers, why were not many of the Percoids, Cyprinoids, and other forms, that are as essentially surface feeders as the *Cyprinodontes* (many of the latter are purely "mud feeders"), as capable of maintaining an existence in the subterranean waters as any species of the latter? Neither is it necessary for us to assume that the structure of the fish should be adapted to feeding on the

* Proceedings Acad. Nat. Sci. Philad., p. 63. † Blind fish.
‡ Catalogue of Fishes in the British Museum, vol. vii. p. 2, 1868.
§ The largest specimen I have seen of *Typhlichthys* is one and seventeen-twentieths inches in length, and the smallest *Amblyopsis* one and eighteen-twentieths inches.
‖ Published in American Journal of Science and Arts, vol. xvi. (2d series) p. 134, 1853.

* Literally "bile-stomach;" probably named from the yellow colour of the fish.

surface, for not only have we in the blind cat fish described by Prof. Cope himself from the subterranean stream in Pennsylvania, an example of a fish belonging to an entirely different family of bottom feeders thriving under subterranean conditions, but the blind fishes of the Cuban caves are of the great group of cod fishes which are, with hardly an exception, bottom feeders. The fact that the food of the blind fishes of the Mammoth Cave consists in great part of the cray fish found in the waters of the cave, as shown by the contents of several stomachs I have examined, and also that one blind fish at least made a good meal of another fish, as already mentioned, shows that they are not content with waiting for what is brought to them on the surface of the water, and that they are probably as much bottom as surface feeders.

Again, in regard to sense of sight, why is it necessary to assume that because fishes are living in streams where there is little or no light, that it is the cause of the non-development of the eye and the development of other parts and organs? If this be the cause, how is it that the *Chologaster* from the well in Tennessee, or the "mud fish" of the Mammoth Cave, are found with eyes? Why should not the same cause make them blind if it made the *Amblyopsis* and *Typhlichthys* blind? Is not the fact, pointed out by Prof. Wyman, that the optic lobes are as well developed in *Amblyopsis* as in allied fishes with perfect eyes, and, I may add, as well developed as those of *Chologaster cornutus*, an argument in favour of the theory that the fishes were always blind, and that they have not become so from the circumstances under which they exist? If the latter were the case, and fishes have become blind from the want of use of the eyes, why are not the optic lobes also atrophied, as is known to be the case when other animals lose their sight? I know that many will answer at once that *Amblyopsis* and *Typhlichthys* have gone on further in the development and retardation of the characters best adapting them to their subterranean life, and that *Chologaster* is a very interesting transitionary form between the open water *Cyprinodontes* and the subterranean blind fishes. But is not this assumption answered by the fact that *Chologaster* has every character necessary to place it in the same family with *Amblyopsis* and *Typhlichthys*, while it is as distinctly and widely removed from the *Cyprinodontes* as are the two blind genera mentioned?

If it is by acceleration and retardation of characters that the *Heteropygii* have been developed from the *Cyprinodontes*, we have indeed a most startling and sudden change of the nervous system. In all fishes the fifth pair of nerves send branches to the various parts of the head, but in the blind fishes these branches are developed in a most wonderful manner, while their subdivisions take new courses and are brought *through* the skin, and their free ends become protected by fleshy papillæ, so as to answer, by their delicate sense of touch, for the absence of sight. At the same time the principle of retardation must have been at work and checked the development of the optic nerve and the eye (which probably exists externally in the young fish), while acceleration has caused other portions of the head to grow and cover over the retarded eye.

Now, if this was the mode by which blindness was brought about, and tactile sense substituted, why is it that we still have *Chologaster Agassizii* in the same waters, living under the same conditions, but with no signs of any such change in its senses of sight and touch? It may be said that the *Chologaster* did not change because it probably had a chance to swim in open waters, and therefore the eyes were of use, and did not become atrophied. We can only answer, that if the *Chologaster* had a chance for open water, so had the *Typhlichthys*, and yet that is blind.

If the *Heteropygii* have been developed from *Cyprinodontes*, how can we account for the whole intestinal canal becoming so singularly modified; and what is there in the difference of food or of life that would bring about the change in the intestine, stomach, and pyloric appendages, existing between *Chologaster* and *Typhlichthys* in the same waters? To assume that under the same conditions one fish will change in all these parts and another remain intact, by the blind action of uncontrolled natural law, is, to me, an assumption at variation with facts as I understand them.

Looking at the case from the standpoint which the facts force me to take, it seems to me far more in accordance with the laws of nature, as I interpret them, to go back to the time when the region now occupied by the subterranean streams was a salt and brackish water estuary, inhabited by marine forms, including the brackish water forms of the *Cyprinodontes* and their allies (but not descendants) the *Heteropygii*. The families and genera having the characters they now exhibit, but most likely more numerously represented than now, many probably became exterminated as the salt waters of the basin gradually became brackish and more limited, as the bottom of this basin was gradually elevated; and finally, as the waters became confined to still narrower limits, and changed from salt to brackish, and from brackish to fresh, only such species would continue as could survive the change, and they were of the minnow type represented by the *Heteropygii*, and perhaps some other genera of brackish water forms that we have not yet discovered.

In support of this hypothesis we have one species of the family, *Chologaster cornutus*, now living in the ditches of the rice fields of South Carolina, under very similar conditions to those under which others of the family may have lived in long preceding geological times; and to prove that the development of the family was not brought about by the subterranean conditions under which some of the species now live, we have the one with eyes living with the one without, and the South Carolina species to show that a subterranean life is not essential to the development of the singular characters which the family possess.

That a salt or brackish water fish would be most likely to be the kind that would contine to exist in the subterranean streams, is probable from the fact that in all limestone formations caves are quite common, and would in most instances be occupied first with salt water then with brackish, and finally with fresh water so thoroughly impregnated with lime as to render it probable that brackish water species might easily adapt themselves to the change, while a pure fresh water species might not relish the solution of lime any more than the solution of salt; and we know how few fishes there are that can live for even an hour on being changed from fresh to salt, or salt to fresh water. We have also the case of the Cuban blind fishes belonging to genera with their nearest representative in the family a marine form, and with the whole family of cods and their allies, to which group they belong, essentially marine. Further than this, the cat fish from the subterranean stream in Pennsylvania belongs to a family having many marine and brackish water representatives. As another very interesting fact in favour of the theory that the *Heteropygii* were formerly of brackish water, we have the important discovery by Prof. Cope of the Lernæan parasite on a specimen of *Amblyopsis* from the Wyandotte cave; this genus of parasite crustaceans being very common on marine and migratory fishes, and much less abundant on fresh water species.

Thus I think we have as good reasons for the belief in the immutability and early origin of the species of the family of *Heteropygii*, as we have for their mutability and late development, and, to one of my, perhaps, too deeply rooted ideas, a far more satisfactory theory; for, with our present knowledge, it is but theory on either side.

F. W. PUTNAM

PASTEUR'S NEW PROCESS FOR THE MANUFACTURE OF BEER*

DURING the last few years several improvements have been introduced into the manufacture of beer; in Germany especially, land of sauer-kraut and hops, much attention has been devoted to this spicy and delicate question. In general, however, the apparatus for this manufacture leaves much to desire, and to this day brewers are far from being in possession of a process anything like perfect. Scientific men have given scarcely any attention to the question, which, perhaps, they consider unworthy of their study; while, like the rest of mortals, overcome by the heat and burden of the day, they perhaps have not disdained at times to raise to their lips the golden beverage, which even the most dainty prefer to the ancient and divine nectar.

Happily, we have commenced to review our past errors; the great masters of science have consented to descend from the ethereal heights of their empire, and to bring to bear upon industrial art their precious co-operation. For my part, I prefer a result to a formula, an application to a cloudy theory. Should some, losing themselves in impenetrable mists, turn away their attention with alarm from the useful pursuits of these men of science who approach with satisfaction the vulgar necessities of this world, let them do so, so long as M. Liebig is willing to be the world's cook, and M. Pasteur its brewer! It is an established fact in the eyes of earnest men, that "science," as Flourens said, "ought not merely to remain a source of self-satisfaction to the soul who has acquired it, and been elevated by it above the crowd, and that it becomes false as soon as it ceases to be profitable to that crowd." Dunoyer said with justice that "he who is a man of science, and nothing more, knows only how to make science useless to himself."

M. Pasteur is one of those men essentially scientific and keensighted, who understand the saying Geoffroy St. Hilaire one day made to re-echo through the Institute, "The social question is the first with which to occupy ourselves at the present day." But it was in that same room that Bert exclaimed, "Let us continue to study Nature in her most secret processes, to discover, to measure, to calculate the forces that she brings into action, having no thought of any useful applications we can put our studies to." Without doubt, with his friend Gay-Lussac, the great mathematician would reproach Pellegrini-Savigny with having degraded Science in occupying himself with questions as to alimentation. But on the other side we have the names of Berthollet, Monge, Chaptal, Conté, d'Alembert, Franklin, Geoffroy St. Hilaire, Arago, and especially Pasteur, for whom posterity will undoubtedly have a profound respect. M. Pasteur has added to his other fruitful inventions a new process for improving the manufacture of beer, for which he asked a patent in June 1871 in the following terms:—

"I desire to take out a patent for five years for a new mode of manufacturing beer, which consists essentially in fermentation sheltered from all contact with air.

"The wort, after being boiled, is turned into vessels of wood or iron, cooled in a current of carbonic acid gas; and then put to ferment.

"This process is founded upon new scientific data which I have expounded elsewhere, and from which it follows that contact with air is most injurious to the manufacture of beer. It is applicable to mild and strong, brown or pale ales.

"I wish the beers made by my process to bear in France the name of *Bières de la Revanche Nationale*—I shall say why elsewhere—and abroad that of *Bières françaises.*

"The disuse of cooling *bacs.*

"No loss by evaporation, &c.

"The abolition of store cellars, for future use.

* Translated from an article by M. A. Jouglet, in the *Moniteur Scientifique* for September 1872.

"An increase of the quantity produced, and, at the same time, an increase in the strength of the beer.

"The development of a very agreeable 'bouquet.'

"No further use for ice-houses, for fermentation at a low temperature.

"Such are some of the principal advantages to be derived from the application of my process, and some of the qualities that will mark the beers *de la Revanche.*"

On Nov. 4, 1871, an additional certificate, accompanied by the sketch here reproduced, was deposited at the Prefecture of the Department of the Seine.

"The annexed sketch," says M. Pasteur in this addition, "represents the construction of the apparatus for the application of the new process of beer manufacture. A description of the design accompanies it.

"The size of this apparatus varies with the importance of the manufacture. It can be made of any size, from one hectolitre to 100,000 hectolitres. When the apparatus is of a somewhat considerable size, the employment of carbonic gas is indispensable to prevent the formation of deleterious ferments—lactic ferment, butyric ferment, injurious alcoholic ferment, &c. The employment of air, previously purified by calcination, by passing it through cotton, or by any other mode, is also a remedy for this drawback. A very small quantity of air is not injurious, perhaps even ultimately improves the quality of the beer. The beer can absorb all the flavour which malt and hops can give it; it can acquire a thoroughly free taste, sparkling limpidity, great strength, and in general all its characteristic qualities, only if we can totally, or in a very large measure, suppress the combustion which takes place in the ordinary process.

"We can also fill up the void which is made in the apparatus during the cooling of the wort, by bringing the apparatus into connection with a vessel full of warm wort, to kill the seeds of disease in the wort and in the beer which is the ultimate result.

"A man-hole is necessary at those parts of the apparatus marked F, F, when they are of great size.

"The cylinders should be surrounded with a muffler of flannel."

On November 25, 1871, M. Pasteur added a new improvement to his invention.

"The facility with which my apparatus may be applied will be increased by the employment of carbonic acid gas, after a more convenient fashion.

"The carbonic gas produced during fermentation, after having passed through a washing-flask, to be freed from any froth it might hold, is delivered into a zinc or tin reservoir, placed a little below the fermenting apparatus. At the lower part of this reservoir are arranged a number of sockets or taps. When it is desired to cool the wort in presence of the carbonic acid, as it is useless to mix up this gas with the liquid, it is sufficient to put one of the taps of the reservoir in communication with one of the tubes of the apparatus F, F, F'. This arrangement enables us to do without a gasometer, and obviates all the difficulties that could result from the movement of a gas which ought to overcome the resistance of liquid. Moreover, as the reservoir always keeps itself full, its capacity need not be very large.

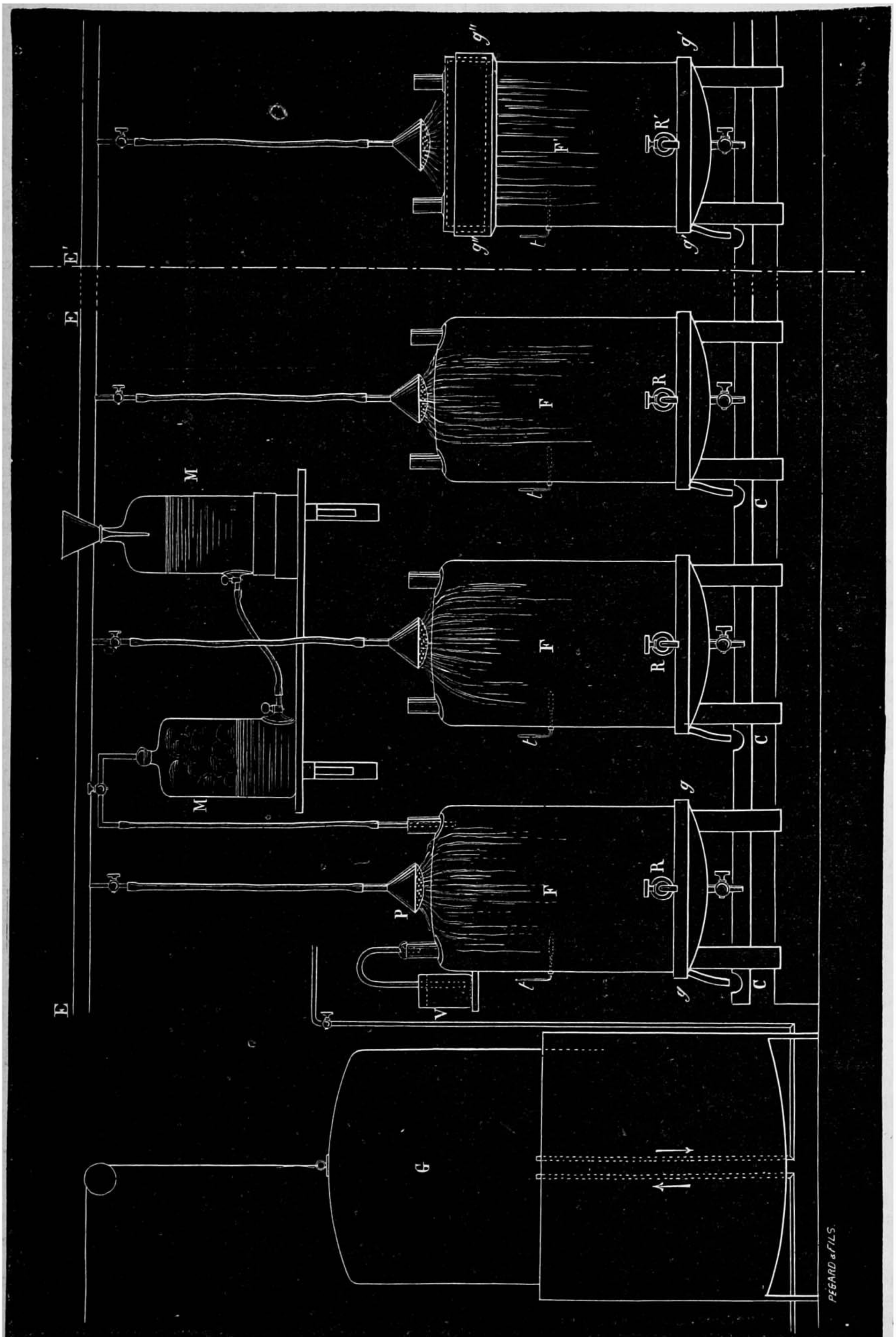
"With a rapid cooling we can dispense with the use of carbonic acid; we can even allow ordinary air to enter in proportion as the bulk of the wort diminished while cooling."

The germs of disease in the wort are killed in the boiling wort, and those which the volume of free air just mentioned may carry, will not have time to develop in the wort, if the cooling process has been prompt—a condition always easy to bring about by having a suitable flow of water, and by having the bulk of wort always comparatively small.

"In reference to these assertions, it may not be useless to recall the proof I formerly gave of the remarkable fact, that liquids the most variable, even common household broth, preserve their limpidity for years by being kept from contact with air, provided that they be deprived of their germs. In the ordinary processes for manufacturing beer, all these germs are carefully accumulated in the wort, and even in the beer; and besides, the aromatic part

APPARATUS FOR PASTEUR'S PROCESS FOR MANUFACTURING BEER

(Lent by the Editor of the "Moniteur Scientifique.")



E, E, E'. Pipe for receiving cold water which is distributed by the nozzles P into the fermenting apparatus F, F, F, F'. M, M. Apparatus for manufactured carbonic acid. C, C, C. Discharge-pipe for the water which is thrown out by the troughs *g*, *g*, *g'*, where it collects very warm at the outset of the operation. F'. Another arrangement of the fermenting apparatus in which the moveable cover closes the cylindrical apparatus by means of the exterior trough *g''*, *g''*, with which the border of the cover dips. G. An ordinary gasometer, with a receiving and egress pipe. The fermenting gas of various apparatus can easily be turned into this gasometer, which afterwards supplies this gas when a new process is set agoing. *t*, *t*, *t*. Thermometers to indicate the temperature for putting in the yeast.

of the hops is utterly destroyed by the oxygen of large masses of air; hence a deterioration of the product and a difficulty in keeping it.

"The cooling of the wort can be hastened by various arrangements. One of the most simple consists in having serpentine or cylindrical tubes placed vertically in the interior of the vessels F, F′, where cold water circulates. The boiling wort can be turned into the fermenting vats themselves, to which the cooling tubes alluded to have been added, besides covering over these vats with a tin cover by hydraulic pressure, or else the boiling wort will cool in a large apparatus F or F′, fitted with cooling tubes for the circulation of water; then, at the moment when fermentation begins, the wort is turned into the fermenting vats closed by their hydraulic covers. It is even possible to make the common refrigerators serve by enclosing them in a vessel full of carbonic acid gas, or of air deprived of germs, and even ordinary air, if the vessel is of small capacity.

"To recapitulate:—the main and altogether novel principle of my process consists in the employment of vats of tin or wood, into which the wort is run as hot as possible, and is cooled by a current of water outside, or outside and inside at once, without any evaporation, over which there is absolute control; so much is this the case that, according to the terms of my patent, nothing is more simple than to transport the wort without danger to the greatest distances. With regard to the action of the air, we can limit it at pleasure, in so far as it is noxious, for we can always annihilate the mischievous influence of the germs it contains. The brewer has, moreover, the control over the action of free oxygen gas, so far as it consumes the aromatic or other very delicate principles. Besides, my process allows the temperature to be kept steadily at any height for the purpose of fermentation. In short, its advantages are valuable for the fermentation of German beer, or for mild fermentation, for we can proceed to the employment of ice or any other powerful means of cooling during the process of fermentation. There, is, however, no distinction between strong and mild fermentation, except in so far as the greater or less specific differences of two yeasts, strong and mild, are concerned. The two yeasts can be kept equal; the fermentation will be accomplished in the cold vats.

"Ere long I shall indicate how we may obtain at pleasure, at all seasons, and in all places, the two yeasts in a state of purity, without having recourse to those of the brewer.

"The ferment which is deposited at the bottom of the vessels, F′, is of a brown colour, because it is mixed with the deposit characteristic of the wort during the cooling process. It will be easy to collect it almost white, and without mixture, either by scraping the surface of the cake which it forms at the bottom of the apparatus, or by introducing at the outset into the apparatus, at the moment when we place the cover on the boiling worts, circular plates, attached to a bar which passes through the cover. This upright bar should terminate in the quadrant of a circle, round the extremities of which it can be turned, and moved up or down. While the wort is cooling, the plate of each apparatus will have its plane in a vertical position, and thus it will remain during the first days of violent fermentation. Then, when the ferment begins to settle down, the plate should be gently lowered until it is horizontal. After the product has been drawn off, a cake of ferment will be found upon the plate."

M. Pasteur made still another addition to this process, which was added to his patent in January 1872. It is as follows:—

"When the yeast in one pan is spoiled from any cause, it is necessary to have recourse to yeast taken from another pan. It then becomes a matter of importance to be able to prepare for one's self in any kind of vessel whatever a yeast deprived of all deleterious germs. I have solved this problem by discovering that the *Mycoderma vini* can be made the nucleus of a mild yeast. It can be made to develop itself in the wort of beer sheltered from contact with the air. I have also discovered that the fermenting principle of the grape is a mild yeast. It is a source to which breweries established according to my process can resort."

This addition is, in my opinion, of great importance. M. Pasteur's researches will not probably end here. Every day brings with it a new idea. At all events, from this time the manufacture of beer has received such valuable improvements as will tend to its increased production and use. The process has not yet received the sanction of long experience, but it appears to have fulfilled all that was expected of it. Some have asserted that M. Pasteur's system involves an enormous expense. I do not believe it; experience will show these objections to be unfounded.

After all I know very well that M. Pasteur may yet be the victim of envy. It will be remembered what annoyance an enemy gave him in connection with his process for improving wines.

M. CHEVREUL

A VERY interesting episode took place at the *séance* of the French Academy of Sciences of September 2, on the occasion of what may be regarded as the academic jubilee of the Dean, the famous chemist, M. Chevreul. The fiftieth year of his membership does not strictly occur till 1876; but it is well known that he would have been elected in 1816, had he not urged the Academy to give the vacant place to M. Proust, his compatriot, and a celebrated chemist, who was old and infirm, and could not afford to wait. M. Faye, as president of the Academy, intimated that the members had resolved, as a token of their estimate of his works, and their regard for his personal character, to present the venerable Dean that day with a medal, without waiting for the arrival of the formal jubilee. The medal represents the features of the illustrious chemist, who bears the weight of his 86 years much more lightly than many of his fellows who are considerably younger than himself. M. Dumas, the celebrated chemist, and permanent secretary of the Academy, in an eloquent and gracefully-worded speech, recounted the many valuable services rendered by M. Chevreul, who modestly styles himself "le doyen des étudiants français," and at the same time bore warm testimony to the personal character of the man. After M. Elie de Beaumont, who had been a pupil of M. Chevreul, had added a few words of veneration and respect for his old master, the latter attempted to respond, but had simply to express his inability to do so. It was in 1806 that M. Chevreul published his first most important work. He was collaborator of Vanquelin: and he has just completed a volume, entitled "Mémoires de l'Académie," a most interesting work, which throws light upon many of the most scientific questions of the day. M. Chevreul is one of the most distinguished chemists of the age; and, besides being Dean of the Academy of Sciences, is Director of the Museum of Natural History at the Jardin des Plantes. He has chosen for his motto that beautiful maxim of Malebranche, which indeed affords a true key to his life, his works, and his discoveries, "*Chercher toujours l'infaillibilité, sans avoir la prétention de l'atteindre jamais.*"

NOTES

IT is stated, on the authority of a private telegram from Bombay of Tuesday last, that letters from Dr. Livingstone, dated July 2, 1872, have been received at Zanzibar. He was still at Unyamyembe, was well, and waiting the arrival of Stanley's second expedition.

THE fourth three-yearly meeting of the French Institute will take place on the 2nd of October, and the yearly public meeting on the 25th of October.

AT the sitting of the French Academy of Sciences, on Sept. 9, a number of communications on the subject of the ravages of the *Phylloxera vastatrix* in the vineyards of France were read by M. Dumas, and referred to the "*Phylloxera* committee" of the Academy. It appears that the disease is making fearfully rapid advances in Provence, threatening the speedy entire destruction of the crop. In the department of Vaucluse it is also rapidly increasing; while in that of l'Hérault it is rather diminishing. All the correspondents agreed that when once a plant is attacked cure is hopeless, and that it is almost impossible to prevent the parasite spreading to neighbouring plants by any other means than complete submersion under water, though the application to the roots of a soil composed of sand, manure, and some insecticide, will delay it for some years. There is no doubt that the wingless insect migrates above ground from the diseased to the healthy plant, and is carried in great quantities by the wind. M. d'Armand, of Marseilles, demanded that a prize of 500,000 fr., or, if necessary, 1,000,000 fr., be offered by the State to any one who shall discover a means of arresting the disease. The pest has made great advances also in Portugal, especially in the neighbourhood of Porto, Villa Réal, Douro, and Santarem; and a Royal Commission has been appointed to investigate fully the causes of a disease which threatens the destruction of one of the most important branches of national wealth, and the best means of curing it.

WE have received from New York copies of the *Tribune*, containing full reports of the A. A. A. S.—the transatlantic expansion of the British Association—contributed by one of the editors of that journal. There can scarcely be imagined a more striking indication of the root that Science is taking in America than this, for the report has necessitated some 2,400 miles of travel, and the white heat of a political contest is raging; and yet it appears: in other words, knowing the cleverness of our transatlantic cousins—it pays!

THE present excessive price of coals is stimulating the wits of every one concerned to endeavour to discover some means of reducing it. Certainly one of the best means would be to increase the supply from beneath the soil of our own country; how this may probably be accomplished is suggested in a letter to the *Liverpool Daily Post* of Sept. 16, by Mr. T. M. Reade, C.E. His suggestion is that in all likelihood coal would be found by boring the district immediately around Liverpool. The whole of the rock on which the town stands, and in fact the whole country, from a fault passing near and west of Neston, under the estuary of the Dee, to the Croxteth fault, just beyond West Derby, belongs to the Trias, which in this locality consists only of two members, the Bunter and the Keuper, the third, or Muschelkalk of Germany, being absent. Eastward the Triassic formation extends as far as Manchester, from which it follows an irregular line as far south as Shrewsbury; but as this portion of the district is deeply covered with the red marls of the Keuper, and as it would take deep sinking to reach the underlying coal (assuming it to be present), Mr. Reade confines his proposition to the district enclosed by lines drawn through Liverpool, Warrington, Chester, and West Kirby, at the mouth of the Dee. The whole of this district has been let down as in a trough, by which the Trias has, to a large extent, been preserved from denudation, and the underlying coal formation is consequently, in places, at a considerable depth below the surface; whether at a workable depth is the question which must be considered. Leaving out of account the red marls, which only occupy a small patch by Upton, in Cheshire, and again by the Weaver opposite Frodsham, the highest rock in the series is the Keuper sandstone, which forms the surface at Oxton, Wallasey, Heswell, and Stourton, in Cheshire, and under a portion of Liverpool, west of what is called the Everton fault —a strip of Keuper sandstone running almost due north from Toxteth Park. The remainder of the Triassic formation consists entirely of the Bunter sandstone, which is itself divided into Upper soft red sandstone, the pebble bed, and Lower soft red sandstone. Under these again, before we reach the highest members of the carboniferous rocks, it is an open question whether we should or should not have to penetrate Permian strata. The Permians have been proved in a few places, principally occurring on the northern boundary of the Trias in a narrow strip, and the total depth being but small. At Croxteth, where coal was formerly worked, the New Red sandstone or Trias is said to be directly superposed upon the coal measures; but a well-boring at Winwick, after penetrating 150 feet of red sandstone, the upper part of which is placed with the pebble beds in the geological survey sheet, was sunk 210 feet through strata consisting of hard red rock, stiff red marl, red and white sandstone, with a zone of limestone bands at the base, the boring terminating at 360 feet from the surface in hard rock. These beds, Mr. Reade is inclined to think, belong to the Permians rather than to the Upper coal measures; but it is doubtful if the Permians would be found under the whole area, as they have evidently been subject to denudation before the New Red sandstone was laid down. If coal is to be bored for at Liverpool, it should be at one of the several places where the Lower red sandstone is thrown up to the surface, the probability being, Mr. Reade thinks, that the upper members of the coal-measures would be reached at the depth of 400 or 500 feet, while the workable coal, or commencement of the middle coal-me asures, would probably be found at a further depth of 1,200 feet. If the shaft were sunk near a fault, it would soon be seen whether it were worth while to sink deeper. Mr. Reade suggests a patch of Lower sandstone, about half a square mile in extent, at Eastham, and a less one at West Kirby, in addition to that about Croxteth on this side of the river. The depth conjectured by Mr. Reade is very much under some of the depths which have been canvassed in estimates of the increased difficulty and costliness of meeting the industrial demand for fuel.

A GREAT international exhibition of fruit will be held at South Kensington, in connection with the Horticultural Department of the London International Exhibition, 1872, on Wednesday, Nov. 6, in which all home and foreign growers of fruit are invited to take part, and for which occasion a liberal schedule of prizes has been issued by the Council.

THE discovery of a new planet, No. 124, by M. Prosper Henry, on the night of September 11-12, is announced from Paris. Its position and motion are as follows:—September 11, $15^m\ 47^h\ 35^s$, Paris M.T.; R.A. $23^h\ 59^m\ 35^s$; Decl. $-0^\circ\ 55'\ 57''$; horary motion in R.A. $-1^s{\cdot}9$, in Decl. $-20''$. Magnitude about 11·7.

DURING the closing hours of the last Congress of the United States an appropriation of 150,000 dols. was made for the purpose of introducing salmon, shad, and other valuable food fishes into the rivers and lakes of the United States, and its expenditure was placed in the hands of Professor Baird, the United States Commissioner of Fish and Fisheries. The late period at which this appropriation was made rendered it difficult to accomplish much in reference to shad, as the season for their hatching was very nearly over; but, notwithstanding this, a very satisfactory beginning to the enterprise is announced by the commissioner.

DR. AUGUSTUS KRANTZ, of Berlin, the well-known dealer in specimens of geology and mineralogy, died on the 6th of April last, in the sixty-second year of his age. This gentleman was well known throughout Europe and America for the immense collections kept for sale by him, and many colleges and other cabinets in the United States contain series purchased from him, furnished at very reasonable prices.

THE Newcastle-on-Tyne College of Physical Science has issued its prospectus for the Session 1872-73. The first Session closed with 70 day and over 100 evening students, and considerable accessions are hoped for. The teaching of Biology is still conspicuous by its absence; but there is so strong an element of Natural History on the governing board of the College that we may hope the just claims of this branch of science may not be disregarded much longer. Why is the obsolete term "Natural Philosophy" retained among the subjects taught? It is here apparently meant to embrace Mechanics, Hydrostatics, and Optics. An examination will be held on October 7 and 8 for four exhibitions of 15*l.* each, tenable in the College for two years, in Arithmetic, Algebra, and Euclid, and either Geology, Heat, or Chemistry.

IN 1871 the important papers of Dr. Petermann upon the Gulf Stream, with their accompanying maps and charts, were translated into English and published by the United States Hydrographic Office, under the direction of Captain R. H. Wyman. Since then two supplements have been issued by the office, including additional information obtained by Dr. Petermann, the second one accompanied by a map of the northern regions of Europe and Asia east of Greenland. This, which is on quite a large scale, gives us the results of the discoveries made up to the end of 1871, including the work done by Lamont, Mack, Johannesen, Payer and Weyprecht, Rosenthal, &c. The text of this supplement contains reports of the cruises of Smith and Ulve, and of Captain Torkildsen, papers on the sea north of Spitzbergen, and on Gillis's Land and King Charles's Land, &c. Petermann is of the opinion that, as far as the discoveries of land go, the results of Smith and Ulve are more important than those of any cruise between Greenland and Siberia for many years past, as they show that the north-east line of Spitzbergen extends across 10½ degrees of longitude instead of the 7½ previously assigned, this extension including the southern coast as well as the northern. The easternmost point reached by this expedition was a little beyond the 28th degree of east longitude.

AT no previous period (says *Harper's Weekly*) has there been so much activity displayed on the part of the United States Government in the way of thorough explorations of its territories, the liberality of Congress at the last session in authorising such having been very great. The operations of the Coast Survey have been largely extended, including the commencement of a triangulation between the coasts of the Atlantic and Pacific. Arrangements have been made for extended surveys by the Navy Department of the North Pacific, and an appropriation also made for the expense of making the observation of the coming transit of Venus. Under the War Department are progressing the new survey of the northern boundary of the United States, between the Rocky Mountains and the Lake of the Woods, the geological survey of Mr. Clarence King along the fortieth parallel, and the surveys in Utah and Nevada by Lieutenant George M. Wheeler; while Dr. Hayden's work in the Interior Department is advancing satisfactorily in its two main divisions, as also that of Major Powell along the Colorado.

THERE are at this time four chemical laboratories in Japan, where the science is taught, three of them being presided over by Germans and the fourth by an American. The chief one is at Osaka, where there are nearly 100 students. The rest are at Kaga, Shidzoka, and Fukuwi. A fifth will soon be opened at Jeddo. The students are said to be fairly intelligent, but their minds are at present encumbered with astrology and other kinds of spurious philosophy.

THE BRITISH ASSOCIATION

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

On the Application of Photography to Copy Diffraction Gratings, by the Hon. J. W. Strutt.

GREAT interest has always attached itself to the beautiful phenomena discovered by Frauenhofer, which present themselves when a beam of light falls on a surface ruled with a great number of parallel and equidistant lines. Their unexpected character, the brilliant show of colour, and the ready explanation of the main point on the principles of the wave theory, recommend them to all; while the working physicist recognises in them the key to the exact measurement of wave-lengths, which has been so splendidly used by Angström and others.

The production, however, of gratings of sufficient fineness and regularity is a matter of no ordinary difficulty. Indeed, the exactness required and obtained is almost incredible. The wave-lengths of the soda lines differ by about the thousandth part. If in two gratings, or two parts of the same grating, the average interval between the divisions differed by this fraction, the less refrangible soda line of one would be superposed on the more refrangible corresponding to the other. In point of fact the gratings ruled by Nobert, to whom the scientific world has been greatly indebted, are capable of distinguishing a difference of wave-length probably of a tenth part of that above mentioned. But in order that the D lines may be resolved at all, there must be no average error (running over a large part of the grating) of $\frac{1}{1000}$ part of the interval between consecutive lines. When it is remembered what the interval is (from $\frac{1}{1000}$ to $\frac{1}{6000}$ of an inch, or even less), the degree of success which has been reached seems very remarkable.

A work requiring so much accuracy is necessarily costly—the reason, probably, why gratings fit to be used with the telescope for the purpose of showing the fixed lines are comparatively rare. The hope of being able to perfect a process for the reproduction of gratings at a comparatively cheap rate has induced me to return at the first opportunity to the experiments described in a preliminary note read before the Royal Society in June last. Although the subject is as yet by no means exhausted, I have thought it worth while to bring before the Section an account of the progress that has been made, with specimens of the results.

The method of procedure is very simple. A dry plate prepared by any photographic process on a *flat* surface of glass or other transparent material not affected by the fluid media employed, is brought into contact with the ruled surfaces of the grating in a printing frame, and exposed to light. In my first experiments I used exclusively as a source of light the image of the sun in a lens of short focus placed in the shutter of a darkened room; but so small a source is not necessary. The light from the clouds or sky, reflected by a mirror through a hole several inches in aperture, will be sufficiently concentrated if the frame be a few feet distant. I have not as yet specially investigated the point, but I believe that if the light were too much diffused the experiment would fail. Much would, no doubt, depend on the perfection of the contact—an element very likely to vary.

The variable intensity of diffused daylight, which it is almost impossible to estimate with precision, has induced me to use exclusively in my later experiments with ordinary photographic plates the light of a moderator lamp. This, with globe removed, is placed at a distance of one or two feet from the printing frame, the distance being carefully measured. Working in this way there is little difficulty in giving consecutive plates any relative exposures that may be required. A collateral advantage is the possibility of operating at any time of the day or night.

With regard to the preparation of the plates, I have latterly been using the tannin process introduced by Major Russell. A preliminary coating with dilute albumen is generally advisable, as any loosening of the film from the glass must be avoided, on account of the distortion that it might introduce. In some states of the collodion, an edging of black varnish put on after the exposure is sufficient to hold the film down. The glasses, after being coated with collodion (I have used Mawson's), are immersed as usual in the silver bath, and then allowed to soak in distilled water, best contained in a dipping-bath. They are then washed under a tap for about half a minute, and put into the tannin solution (about 15 grains to the ounce) held, in my practice, in a small dish. I usually prepare my plates in the evening, standing them up to dry on blotting-paper. In the morning they are in a fit state for use. Artificial heat might no doubt be used if a more rapid drying were desired.

At a distance of one foot from the lamp the exposure required is four or five minutes. The development is the most critical part of the process. The pyrogallic solution should contain plenty of acid (acetic or citric), and its action must not be pushed too far, the mistake which a photographer accustomed to negative work is most likely to make. At this stage the spectra given by a candle flame are not very brilliant, on account of the iodide of silver still covering the parts which are to be transparent. Any trace of fog is especially to be avoided. I have experienced advantages in many cases from a solution of iodine in iodide of potassium applied to the film previously to fixing; but its action must be carefully watched, or too much silver will be converted. The iodide of silver is then cleared away with hyposulphite of soda or cyanide, followed by a careful washing under the tap.

With regard to the gelatine copies, I have not much to add to the account read before the Royal Society. The process is very simple, and some of the results very perfect; but I have not hitherto succeeded in sufficiently mastering the details. Plates apparently treated in precisely the same manner turned out very differently. That difficulties should arise is not very extraordinary, considering the novelty of the method; but it is curious that some of the very first batch prepared are among the best yet produced. The value of the results is so great that I have no intention of abandoning my attempts, and perseverance must at last secure success.

I will now say a few words about the performance and prospects of the new copies. Their defining power on the fixed lines in the solar spectrum is all that could be desired, being, so far as I can see, in no way inferior to the originals. In the third spectrum the 3,000 to the inch gratings show the line between the D's, if the other optical arrangements are suitable. The fourth line of the group, *b*, is distinguished with the utmost ease. I am not sufficiently familiar with spectroscopic work to make an exact comparison, but I presume that two prisms of 60° at least would be required to effect as much. I am here speaking of photographs on worked glass. With ordinary patent plate, although very good results may be obtained, if tested by the naked eye only, it is a great chance whether the magnifying power of a telescope will not reveal the imperfect character of the surface.

With direct sunlight the light is abundantly sufficient, but it is here in all probability that the weak point of gratings lies. It should be distinctly understood that where light is deficient gratings will not compete with prisms. There are cases, however, where the scale might be turned by the opacity of all highly dispersive substances to the rays under examination. Even if glass be retained as the substratum, it may be used in a very thin layer, while prisms are essentially thick. The immense advantage of a diffraction spectrum for the investigation of dark heat need not here be insisted on. Taking all things into consideration, it is probable, I think, that photographed gratings will supersede prisms for some purposes, though certainly not for all.

The specimens in the hands of Mr. Ladd are copies of two gratings by Nobert, each of a square inch in surface, the one containing 3,000 and the other 6,000 lines. The latter cost about twenty pounds.

SECTION C.—GEOLOGY

Monday, Aug. 19.—*On the Occurrence of Erect Bases or Trunks of Psaronius in the Devonian Rocks of New York, U.S.A.*, by Prof. James Hall.

During the year 1870 some excavations were made in beds of fine sandstone, referred at that time to the upper part of Hamilton's group, but which probably belong to beds higher in the series. In these beds several thousand trunks of tree-ferns were found in an upright position, with their bases resting in and upon a bed of clay, in which they appear to have originally grown. In the clay, and in the sandstone above, to the height of two or three feet, great quantities of vegetable substance occurred. Principal Dawson refers these trunks to the genus *Psaronius*, and he has determined two or more species from the locality.

These facts were held to indicate a point of comparatively dry land upon the eastern margin of the Devonian Sea. Receding from this ancient shore we find the sands and slates to become finer, and the latter to change into calcareous muds. For some distance the shells occurring in these beds are all Lamellibranchs, and it is only when we have travelled a considerable distance to the westward that Brachiopods appear. The author then entered into some detail as to the mode of accumulation of these beds, which are admirably exposed along a line of outcrop 300 miles in length.

Sur les Animaux Fossiles du Mont Leberon, Vaucluse, by Prof. A. Gaudry.

The author remarked that the fossils found by him and others in this place bore a striking similarity to those he had before collected in Attica. In comparing the 4,940 bones from the latter place with the 1,200 from the former, he had been much struck with the great variations exhibited by animals that seem to descend from the same parent. The presence of numerous and large herbivores proves the existence of a considerable extent of meadow-land during the Miocene period.

Brief Notice of the Present State of our Knowledge in connection with the Brachiopoda, by Thomas Davidson, F.R.S.

The object of this paper was "not to trouble you with details, but to mention, in general terms, what has been the advance effected in this portion of palæontology since 1853, the period at which I first published my general introduction." Mr. Davidson first alluded to the general question of classification, dissenting from the views of Prof. Morse, who wished to remove the Brachiopoda from the Mollusca, and to place them with the Annelides. The great importance of the Brachiopoda to the palæontologist was then dwelt upon, and the author remarked that "many instances are on record where the sight of a few specimens of Brachiopoda have enabled a palæontologist to determine accurately the age of a rock in some distant land to which he had no access." Mr. Davidson stated that the number of so-called species of recent forms amounted to about 100, but that probably the number would have to be reduced to about 60. "The number of so-termed species of *Lingula* had been greatly exaggerated, and a certain number of the others are known only by a single specimen."

Tuesday, Aug. 20.—Mr. H. Woodward read his *Sixth Report on Fossil Crustacea*. The report was illustrated by a large number of diagrams, and announced the discovery of new crustacean forms in Silurian, Coal Measure, and Permian rocks.

Remarks on the Genera Trimerella, Dinobolus, and Monomerella, by Thos. Davidson and Prof. W. King. The authors proposed to group these three genera into a new family to be called Trimerellidæ. It was shown to be structurally allied to the Lingulidæ, and it was inferred that the two families were genetically related. This is a point of great interest, inasmuch as the Lingulidæ are the earlier forms, occurring in Cambrian rocks, whilst the Trimerellidæ first appear in the Silurian strata. The Cambrian Lingulas have a horny shell, and so too have generally the animals associated them. In later formations the Brachiopods and other animals have much more calcareous shells; and from these facts it was inferred that lime was less abundant in the Cambrian sea than during later periods. As the result of long labour in this field of research, the authors were led to adopt the doctrine of evolution of species "effected mainly through the operation of Divine laws, and not by purposeless or accidental modifications." The paper concluded with detailed descriptions of the structure of the Trimerellids.

The Rev. John Gunn's paper was then read *On the Prospect of Finding Productive Coal Measures in Norfolk and Suffolk, with Suggestions as to the Places best adapted for an Experimental Boring*. The author controverted the views expressed by Sir R. Murchison as to there being no coal beneath these counties, and on the following grounds:—The "Anglo-Belgian Basin," in which the forest bed was deposited, is bounded by the chalk on the west and south, and by older rocks on the east. It was contended that this area has been characterised by vegetable growths at several successive periods; and that as regards the coal-growths, these were accumulated in a basin bounded by the carboniferous limestone, just as the forest-bed was accumulated in a basin bounded by the chalk. Hunstanton was suggested as the best place to bore; because there the cretaceous rocks have been denuded, and there too some of the oolites are absent. Probably the bore would not exceed 1,000 feet in depth.

An interesting paper was then read by the Secretary, forwarded from Bonn by G. vom Rath, *On a remarkable Block of Lava ejected by Vesuvius during the great Eruption of April* 1872, *proving the Formation of Silicates by Sublimation*. This was a block of old lava which it is assumed had been floating in the melted lava of the late eruption, and was subsequently ejected by the volcano. It shows that in its interior there were formed crystals of pyroxene, mica, sodalite, specular iron, and magnetite;

whilst at the exterior the pyroxene was melted and the leucite destroyed.

The author particularly pointed out that sodalite, which was found sublimed in the interior of the block, is the silicate most rich in sodium. This he contended was not an accidental circumstance, but resulted from the percolation of sea-water charged with chloride of sodium. The author remarked that the study of such matters is conducting us to the conclusion that the quantities of water, hydrochloric, and sulphuric acid, &c., exhaled by craters and streams of lava, are not only an accompanying phenomenon in the production of volcanic rocks and mineral aggregates, but that they are essentially co-operating at their origin. If once we succeed in proving and explaining the origin of minerals through vapours, or under the co-operation of vapours, then the key to many problems relating to the plutonic rocks and their minerals will be found.

A few Remarks on Submarine Explorations, with Reference to M. Delesse's work entitled "Lithologie du fond des mers," by J. Gwyn Jeffreys, F.R.S.

The lithology of the sea-bottom is not only a vast subject in its various relations to natural history and physical science, but is especially interesting in a geological point of view, because every part of our globe has been at one period or another covered by the sea. Mr. Jeffreys contended that it is almost impossible to ascertain with any degree of certainty what stratified formations are marine, unless we find in them such remains of marine animals as were capable of being preserved. Exceptions doubtless occur, *e.g.* where the stratum had been subject to the action of carbonic acid, produced by the subsequent passage of rain or fresh water; in which case all cretaceous organisms might have been dissolved before they became silicified or petrified. He then gave a short account of submarine explorations, from the time when O. F. Müller first used a dredge for scientific purposes (about 1772), to the present day; and he summarised the results of the expeditions conducted by his colleagues and himself on board H.M.S. *Porcupine*, under the auspices of the Royal Society in 1869 and 1870. But next to nothing is known of the enormous tracts of sea-bed which underlie the depths of the ocean in both hemispheres. He attributed the diffusion and geographical distribution of the marine invertebrate fauna to the action of currents, and not to voluntary migration.

M. Delesse's work was recently published at Paris, and consists of two octavo volumes, besides an atlas of charts and maps. The precise date of publication does not appear; the dedication is dated December 1, 1871. It forms part of a series called "Publications scientifiques industrielles," and purports to have been published with the sanction of the Ministers of Marine and Minister of Public Works.

While giving M. Delesse full credit for the laborious and conscientious manner in which he has evidently performed his great task, Mr. Jeffreys regretted that he had omitted to notice the reports on deep-sea explorations published by the Royal Society in 1869 and 1870, or the Address of Mr. Prestwich (the late President of the Geological Society), which was published in May 1871, and particularly treated of those reports. M. Delesse is a foreign member of the Geological Society. By consulting what had been published on the subject, M. Delesse would have been able not only to give fuller information, but to correct errors which unavoidably occur in an extensive compilation. For instance, his map of France during the tertiary epoch does not show the communication which has been proved by naturalists and geologists to have then existed between the Bay of Biscay and the Gulf of Lyons. According to M. Delesse, there has been no communication since the Liassic period between the Atlantic and the Mediterranean north of the Pyrenees. His division of the French marine fauna into three provinces (Celtic, Lusitanian, and Mediterranean) does not agree with modern observations. Zoophagous mollusca do not, as stated by him, live on those which are phytophagous; pebbles ("*galets*") are not everywhere unfavourable to mollusca, even on coasts exposed to a stormy sea; and foraminifera never crawl at the bottom of the sea. But it is to be hoped that these omissions and errors will be rectified in another edition of a work so desirable and important to scientific inquirers.

Mr. W. Boyd Dawkins, F.R.S., then read his paper *On the Physical Geography of the Mediterranean during the Pleistocene Age.* The author showed from the researches of M. Gaudry that during the late Miocene period it is probable that there was some communication between Attica and Africa. During the Pliocene period a similar communication must have existed at some part or parts of the Mediterranean area. The object of this paper was to show that a like union existed during the Pleistocene age. The palæontological evidence was first gone over. It was shown that African mammalia are found at Gibraltar, in river gravels near Madrid, in Sicily, Malta, the Morea, and in Candia; particular reference was made to the occurrence of a small species of Hippopotamus (*H. Pentlandi*) in these localities, and it was contended that there must have been communication between them and with Africa.

An examination of the soundings makes this probable. It is found that the Mediterranean consists of two deep basins, separated from each other by comparatively shallow water, one barrier extending from Africa, past the Straits of Gibraltar to Cadiz, and the other reaching from Tunis, past Sicily and Malta, to join Italy. An elevation of 2,000 feet would effect this. It was pointed out that the existence of such a mass of high land in the south of Europe must have had an important effect upon the climate of the period.

Mr. Charles Moore's paper *On the Presence of Naked Echinodermata (Holothuria) in Oolitic and Liassic Beds*, was then read. Soft-bodied animals, such as these, are rarely found in a fossil state; but the author had fortunately discovered some minute wheel-like plates, somewhat resembling those of a recent Greenland species, and which he referred to at least four different species of Holothuria. Some of these plates indicate structures not hitherto seen in recent species.

Mr. J. E. Lee read a *Notice of Veins or Fissures in the Keuper filled with Rhætic Bone-bed, at Goldcliff in Monmouthshire.* There are exposed on a scar of Keuper marl, bare at low water, a number of rounded masses of irregular form, but of great length, consisting wholly of bone-bed. The author presumed that these projections are the casts of fissures in the marl which were afterwards filled up with bone-bed. Mr. C. Moore afterwards made some remarks on the extraordinary richness of the bone-bed.

Wednesday, August 21.—Mr. J. H. Judd communicated through Mr. Hughes, a note *On the Discovery of Cretaceous Rocks in the Islands of Mull and Inch Kenneth.* In the former they are seen at several places, and the author supposed that they would be found underlying a great part of the volcanic area of this district. The rocks are all of upper cretaceous age and lie unconformably upon the Jurassic series and older rocks. Like all other rocks of these islands the cretaceous beds are penetrated by intrusive dykes and sheets of trap. Mr. Judd observed, that this discovery gave great confirmation to Prof. Geikie's views as to the Tertiary age of the volcanic rocks of the Hebrides.

Mr. T. A. Readwin's paper, *On the Coal and Iron Mines of the Arigna District of the Connaught Coal Measures, Ireland*, was then read in abstract.

The shales overlying the Upper Limestones of district were surmised by the author to belong to the Yoredale Series. Over these there are grits and shales with three seams of coal which the author referred to the Gannister Series, remarking that a bed of true "gannister" occurred there.

The coal field was divided into three districts, each of which was described by the author. He noticed at some length the clay-ironstone bands and nodules which occur over a much larger area than do the coals. The ironstone is richer and purer than most of our English clay ironstone. The author believed that the time had come for a vigorous and scientific exploration of the district, which he felt convinced would soon become, as Sir Robert Kane had long ago predicted, "an important centre of industry for the interior of the country."

SECTION D.—BIOLOGY

On Deep Sea Dredging round the Island of Anticosti in the Gulf of St. Lawrence, by T. F. Whiteaves, F.G.S.

Depths of from 100 to 250 fathoms were successfully explored during July and August 1871. The temperature of the deep sea mud was found by using a common thermometer to be almost invariably 37° or 38° F. About 100 species of Invertebrata new to the Gulf of St. Lawrence were collected. These included a remarkable foraminifer, *Marginulina*, with spinous processes from the first chamber, *Grantia ciliata*, a new *Pennatula*, &c. Two rare Echinoderms were collected—the well-known *Schizaster fragilis*, and the curious *Calveria hystrix* of Wyville Thomson. Nearly all the marine invertebrates of the northern part of the Gulf of St. Lawrence are purely Arctic species. Three-fourths of the mollusca of Greenland range as far south as Gasté Bay. The species which belong exclusively to the deep sea in Canada have a decidedly Scandinavian aspect.

Preliminary Notice of Dredgings in Lake Ontario, by H. Alleyne Nicholson, M.D., D.Sc.

In this communication the author gave a short preliminary account of a series of dredgings carried out in June and July in Lake Ontario. With a praiseworthy appreciation of the value of such researches, the Provincial Government of Ontario had placed at the author's disposal a sum of money to be expended in this investigation, and the results had been very satisfactory. The dredgings were carried on partly in a yacht and partly in a small paddle-wheel steamer, and were prosecuted wholly by hand, the apparatus employed being similar to that used in marine dredging, except that a bag of embroidery canvas was attached outside the ordinary net, an addition rendered necessary by the exceedingly fine nature of the mud at great depths.

Upon the whole, the results obtained in Lake Ontario agreed very fairly with those obtained in Lake Superior in 1871, there being a general conformity in the phenomena observed in both areas. The fauna of Lake Superior, however, so far as deep water is concerned, is decidedly richer than that of Lake Ontario, whilst some of the more remarkable species discovered in the former appear to be altogether absent from the latter. As might have been anticipated, the fauna of Lake Ontario is not extensive, though some forms occur in great profusion. The shallow-water fauna is very rich in individuals, and the number of species is quite considerable for fresh water. Beyond eight or ten fathoms, the fauna becomes very scanty; and when depths of from twenty to fifty fathoms are reached, the list becomes reduced to some Annelides and Amphipod Crustacea. The nature of the bottom, also, at great depths is very unfavourable to life, consisting almost everywhere of a fine impalpable mud or clay, the temperature of which is very low.

Out of thirty-one forms in all discovered by the author in Lake Ontario, the most interesting were the Annelides and Crustaceans. The Annelides were very abundant, and consist of species of *Nephelis, Clepsine, Saenuris,* and *Chirodrillus,* some of the Leeches presenting phenomena of special interest. Of the *Crustacea,* the most important is a little Amphipod, which occurred plentifully in from thirty to forty-five fathoms, and which the author identified with the *Pontoporeia affinis* of the Swedish lakes. This species, and the Stomapod, *Mysis relicta* of Löven, are found in Lakes Wetter and Wener in Sweden, and it is well known that they have been supposed upon good grounds to support the view that these lakes had been at one time connected with the sea. It is, therefore, a very interesting fact that these crustaceans should both have been found in Lakes Michigan and Superior. The *Pontoporeia* the author had now detected in Lake Ontario; but it was a curious fact that the *Mysis,* which is of common occurrence in Lake Superior, should not have been found to occur at all in the dredgings carried on in Lake Ontario.

On the Flora of Moab, by A. W. Hayne, M.A.

The 250 plants found in Moab from the beginning of February to the middle of March, belong to 58 natural orders, of which by far the best represented are Leguminosæ with 35 species, Compositæ and Cruciferæ each with 26, and Graminaceæ 23. The remainder belonged to Liliaceæ, Scrophulariaceæ, Labiatæ, Boraginaceæ, Umbelliferæ, etc. From the greater abundance of springs the Eastern shore of the Dead Sea is comparatively fertile. The most conspicuous difference which results is the abundance of the date palm, of which on the West only a single clump survives near Jericho.

On the Structure and Development of Mitraria, by Prof. Allman, F.R.S.

Several specimens of the remarkable larval form, to which John Müller gave the name of *Mitraria,* were obtained by Prof. Allman in the Gulf of Spezzia, and were made the subject of careful study of structure and development. Mecznikoff had recently examined another species of the same form, and the author was enabled to confirm the main result arrived at by him, that *Mitraria* was the larval form of an annelide. In some fundamental points, however, regarding the process of development, his observations did not agree with those of the Russian zoologist; while in structure there are some important features which have not been described by either Müller or Mecznikoff, differences which may, in some cases at least, depend on actual differences between the species examined.

The nervous system is well developed, and consists in the principal central portion of a large quadilateral ganglion, formed by the union of two lateral ones, and situated on the summit of the transparent dome-like body of which the larva mainly consists. From this two very distinct chords are sent downwards, so as to form a pair of commissures with two small ganglia, which are situated at the opposite side of the alimentary canal. Besides these, two other small ganglia exist in the walls of the dome, at the oral side of the great apical ganglion, and two similar ones at the ab-oral side. These send off numerous filaments, which dive at once into the walls of the dome, while each sends off a long filament to the region where the alimentary canal begins to bend downwards towards its ab-oral termination. The great apical ganglion supports two sessile ocelli, with pigment and lens, and two small spherical vesicles, each containing a clear spherical corpuscle. These last the author regards as auditory capsules.

A system of vessels was also described. This consists mainly of a sinus which surrounds the great apical ganglion, and sends off three branches, which run in a radial direction in the walls of the dome, two lateral and one ab-oral, and appear to open into a sinus which surrounds its base.

In the progress of development the ab-oral end of the alimentary canal becomes elongated in the direction of the axis of the dome, carrying with it the walls of the base of the dome, which are to form the proper body walls of the future worm, and in this way a long cylindrical appendage becomes developed, and hangs from the central point of the base. At first there is no trace of segmentation, and this is subsequently induced on the cylindrical body of the worm by the formation of consecutive annular constructions.

The process of development as observed by the author in the species of *Mitraria* examined by him thus differs in several points from that observed by Mecznikoff. Among these the most important is that the ventral side of the worm is formed simultaneously with the dorsal instead of subsequently to it and independently of it, as in the case described by Mecznikoff. The development of the worm was not traced to the ultimate disappearance of the dome-like body of the larva.

On the Whales of the Antwerp Crag, by Prof. Van Beneden.

A brief account was given of the great accumulation of bones of fossil cetacea, or rather of whales, which are found in the Antwerp Crag, and of which the greater part belong to species new to science. These primitive whales were all small in size, and in that respect have no existing representative except the Neobalæna of New Zealand. It is only in the Upper Crag that we find representatives of larger species which actually exist such as those of the genera of Balæna, Megaptera, and Balænoptera.

Prof. Flower said that the excavations at Antwerp had revealed a perfect cetacean burial ground. Under the superintendence of a *savant* who had a most intimate acquaintance with the osteology of recent whales, the skeletons of the extinct species had been almost reconstructed in the Brussels Museum. It was a remarkable thing that these ancient whales were all small. It was the reverse of what happened in most other cases where the ancient representatives of any type were generally far larger than those at present existing.

Mr. Sclater inquired what was the relation between the cetacea of the Antwerp and Suffolk Crag.

Prof. Van Beneden replied that they were identical. The English material was not in itself sufficient for independent determination; but with the knowledge he had acquired from the more perfect remains, he was able to identify those from the Suffolk Crag.

Prof. Allman said that there was a parallel to the case of the whales in the dwarf fossil elephant of Malta. This was of the more interest, as the affinities of the elephant and of the whale are by no means remote.

On some points in the Development of Vorticellidæ, by Prf Allman.

The author described, in a beautiful branched and clustered vorticellidan, a process different from any which had been recorded by those observers who had described the so-called encysting process, and the behaviour of the "nucleus" in the Vorticellidæ.

In almost every cluster some of the zooids composing it had become greatly altered in form. They had increased in size, and instead of the bell-shaped form of the others had assumed a globular shape, and had lost both oral orifice and ciliary apparatus, while their supporting peduncle had ceased to be contractile.

In the younger ones the contractile space of the unchanged zooid was still very evident, but was fixed, showing no tendency to alteration of size, and the so-called nucleus was very distinct and larger than in the ordinary zooids. The whole was enveloped in a transparent gelatinous-looking investment.

In a slightly more advanced stage another envelope, in the form of a brown horny capsule, begins to be secreted between the proper wall of the zooid and the external gelatinous investment. It is at first thin and smooth, but it gradually acquires considerable thickness, and becomes raised on its outer surface into ridges enclosing hexagonal spaces.

In this stage the capsule has become too opaque to admit of a satisfactory view into its interior; but if the capsule be carefully opened its contents may be liberated so as to render apparent their real nature. It will be then seen that these consist of a minutely granular semi-fluid plasma surrounding the "nucleus," which has much increased in size and occupies a large portion of the cavity of the capsule. The condition of the contractile space could not be determined; it has probably altogether disappeared.

In a further stage the "nucleus" has undergone an important change; for, instead of the long cylindrical form it had hitherto presented, it has become irregularly branched, has acquired a softer consistence, and has moreover broken itself up into two or more pieces. This change in the "nucleus" is invariably accompanied by the appearance of nucleated cell-like bodies, which are scattered through the corpuscular plasma which had filled the rest of the capsule. They are of considerable size, of a spherical form, and with their nucleus occupying the greater part of their cavity, and having its nucleolus represented by a cluster of granules.

In other capsules, apparently the more advanced, no trace of the so-called nucleus of the vorticella body could be detected, and it seems to be entirely replaced by the spherical nucleated cells, which had now still further increased in number. It is impossible not to regard these cells as the result of the disintegration of the nucleus, and the conclusion is a legitimate one that they are finally liberated by the natural dehiscence of the capsule, and become developed into new vorticellidans.

On the Structure of Noctiluca, by Prof. Allman.

The author gave an account of some researches he had made on *Noctiluca miliaris*. They were mostly confirmatory of the results arrived at by other observers, more especially by Krohn, Quatrefages, Busch, Huxley, and Webb, while they further served to supplement the observations of these zoologists.

At one end of the meridional depression is the vibratile flagellum with the mouth at its base, and here the depression becomes quite superficial, while the opposite end is much deeper and is here abruptly closed. Just outside of this deep end of the depression there commences, by a funnel-shaped enlargement, a very slightly elevated ridge of a firmer consistence than the rest of the body; it terminates abruptly after running down, in a meridional direction, over about one-third of the circumference of the body. The author had reason to believe that this ridge is traversed in its length by a canal which opens close to the ab-oral extremity of the meridional depression by a funnel-shaped orifice, thus giving support to the opinion of Huxley, who believes that *Noctiluca* is provided with an anal orifice. The mouth leads into a short cylindrical gullet, and the author confirmed the existence of the vibratile cilium contained within the gullet, as originally described by Krohn; and of the ridge, with its projecting tooth, described by Huxley as existing in the gullet walls. The floor of the gullet is formed by the central mass of protoplasm, here naked and in direct contact with the surrounding medium. The vibratile cilium springs from this floor, and near the root of the cilium is a depression in the floor which can be followed for a little distance into the protoplasm.

Besides the well-known branching processes which radiate from the central mass of protoplasm to the walls of the body, there is also sent off from the central mass a broad, irregularly quadrangular, plate-like process, which extends to the outer walls, where it becomes attached along the line of the superficial meridional ridge. The lower free edge of this broad process is thickened in the manner of a hem.

In contact with the central protoplasm is the nucleus, a clear spherical body about $\frac{3}{2000}$ of an inch in diameter.

The body walls are composed of two layers—an external thin, transparent, and structureless membrane, and an internal thin granular layer of protoplasm, which lines the structureless membrane throughout its whole extent, and which receives the extremities of the radiating processes from the central mass. Under the action of iodine solution and other reagents, the protoplasmic layer may be seen to detach itself from the outer structureless membrane, and, along with the radiating bands, contract towards the centre. It admits of an obvious comparison with the primordial utricle of the vegetable cell.

The flagellum, which is given off close to the margin of the mouth, is a flattened band-like organ, gradually narrowing towards its free extremity, and with its axis transversely striated like a voluntary muscular fibre throughout its whole length. It seems to have the power of elevating its edges, so as to render one of its surfaces concave, and thus becomes converted into a semi-tube, which may assist in the conveyance of nutriment towards the mouth.

The nucleus is a spherical vesicle, with clear colourless contents, among which minute transparent oval corpuscles may usually be detected. When acted on by acetic acid, the difference between the contents of the vesicle and its wall becomes very apparent, and the contents may now be seen accumulated towards the centre as a minutely granular mass, with some of the oval corpuscles entangled in it.

The radiating offsets, which extend from the central protoplasm to the peripheral layer, contain well-defined clear corpuscles which slowly change their relative places, as if under the influence of very feeble currents. These offsets, indeed, closely resemble the radiating protoplasm filaments which extend from the protoplasm, surrounding the nucleus, to the walls of the primordial utricle in the vegetable cell. The peripheral layer contains scattered through it numerous minute cell-like bodies. These are spherical and of various sizes; in the larger ones a distinct central nucleus may be detected.

It is scarcely correct to regard the central mass of protoplasm as a true stomach. The author had failed to find any evidence of a permanent gastric or somatic cavity, and he regarded the protoplasm mass to which the gullet leads as representing the "parenchyma" of the Infusoria, and, like this, allowing of the solid food being forced down into it from the gullet and there encysted in extemporaneously formed vacuolæ. The food also frequently forces its way from the central mass into the radiating processes, and diatoms and other microscopic organisms may be seen in these processes enclosed in cyst-like dilatations of them, extemporaneously formed for their reception at various distances from the central protoplasm.

It was considered probable that the canal which seems to exist in the superficial ridge affords exit for certain effete matters, which may be conveyed to it through the process, by which it is kept in connection with the central protoplasm.

Our knowledge of the phenomena of reproduction and development in *Noctiluca* is still very imperfect, and the author saw little which seemed capable of throwing additional light on this subject. He agreed, however, with Huxley in regarding it as probable that the nucleated cell-like bodies which are present in the peripheral layer of protoplasm have a reproductive function, and are destined after liberation to become developed into new individuals.

From the account now given it will be apparent that *Noctiluca* consists essentially of an enormously vacuolated protoplasm, involving a nucleus and enclosed in a structureless sac, the vacuolation taking place to such an extent as to separate the contents into a peripheral layer of protoplasm which remains adherent to the outer sac, and into a central mass which is kept in communication with the peripheral layer by processes of protoplasm which pass from one to the other. The author believed that the nucleus of *Noctiluca* had a significance different from that of the so-called nucleus of the ordinary Infusoria, and that it admitted of a closer comparison with the true cell-nucleus. He was of opinion that the nearest ally of *Noctiluca* would be found in the somewhat anomalous infusorial genus *Peridinia*.

In conclusion the author detailed some observations he had made on the luminosity of *Noctiluca*; and he gave reasons for maintaining that the seat of the phosphorescence is entirely confined to the peripheral layer of protoplasm which lines the external structureless membrane.

On the Structure of Edwardsia, by Prof. Allman.

The structure of this beautiful little actinozoon differs in many important points from that of both the zoantharian and alcyonarian polypes. It was shown that just within the mouth the walls of the stomach sac project into the cavity of the sac in such a way as to form eight complicated frill-like lobes; that the eight vertical, radiating lamellæ which project into the body cavity from the outer walls, and are composed of parallel longitudinal fibres enclosed between two membranous layers, do not reach the stomach sac in any part of their course, and that eight strong muscular bundles pass symmetrically through the whole length of the body cavity, being attached at one end to the disc which carries the tentacles, and at the other to the floor of the body cavity, while they are free in their intervening course.

Attached along the length of about the posterior half of each muscular bundle is the long sinuous generative band, with its chord-like craspedum loaded with thread cells. Just before terminating at the lower opening of the stomach sac each of the eight generative bands enters a most remarkable pectinated organ, which appears to be quite unrepresented in any other group of the Cœlenterata. It was difficult to suggest the true significance of these organs; their relation to the generative bands might lead to the belief that they are testes, or they may be analogous to the so-called cement glands which exist near the outlet of the oviducts in some of the lower animals. In this case they might supply some additional investment to the ova at the time of extrusion.

The author regarded *Edwardsia* as presenting a very distinct type of actinozoan structure, which occupies an intermediate position between that of the zoantharian and that of the alcyonarian polypes. He also compared it with the extinct rugose corals of the palæozoic rocks to which it corresponds in the numerical law of its body segments, and of which it might in some respects be regarded as a living non-coraligenous representation.

On the Structure of Cyphonautes, by Prof. Allman.

This remarkable little organism, whose structure and ultimate destination have been variously described by different observers, was obtained by the author in considerable abundance in Moray Firth. The animal is enveloped in a mantle, and the whole enclosed in a delicate, transparent, structureless test formed by two valve-like triangular plates which are in contact along two edges, and separated from one another by a narrow interval along the third. Its form is thus that of a very much compressed cone or pyramid. The author distinguishes by the term base the broader edge where the two plates of the test are separated from one another; while the other two edges are distinguished as the anal and ab-anal edges. The apex is the angle opposite to the base, and here a narrow passage exists through which the fleshy walls of the mantle are brought into immediate contact with the surrounding water.

In the base are two large oval openings, one, the larger, situated towards the anal edge, and the other towards the ab-anal. The former leads directly into the cavity of the mantle. Its edges are prolonged by a membranous lobe ciliated on its margin, and uninterruptedly continued round the anal side of the opening, but deficient on the opposite side. The interior of the lobe is occupied by a cavity.

A large part of the mantle cavity is occupied by the pharynx, a spacious thin-walled sac which opens into the mantle cavity by a long curved somewhat S-shaped slit with thickened and ciliated margins, which, at one side, are continued beyond the large opening situated near the anal side of the base in the form of two short ciliated tentacles. Towards the apex the pharynx becomes suddenly narrow, and is here lined by vibratile cilia, and marked by circular striæ which possibly indicate the presence of sphincter fibres. It now turns towards the anal side, and then bends downwards towards the base, and enters a thick-walled subcylindrical stomach. This runs towards the base parallel to and a little within the anal edge of the test, and is ultimately continued into a short straight intestine, which terminates by an anal orifice in the mantle cavity near the outer opening of the latter. From the upper part of the walls of the pharynx a narrow bundle of fibres passes to the apex of the mantle cavity.

Upon each side of the pharynx and lying against the stomach and intestine is a large oval mass. Its situation would suggest the probability of its being a hepatic organ, but it is altogether so enigmatical that it would be rash with our present knowledge of it to insist on assigning to it any special significance.

In contact with each of these enigmatical organs is a small tubercle, from which a bundle of short fibres pass off in a radiating direction. The resemblance of these bodies to a pair of nervous ganglia is obvious, but the author was more inclined to regard them with Schneider as indicating points of attachment of the contained animal to the two valves of the test.

The smaller of the two openings in the base, that, namely, which is situated near the ab-anal edge of the animal is, like the other, surrounded by a hollow membranous lobe with ciliated margin. This is uninterruptedly continued round the ab-anal side of the opening, but is deficient on the opposite side. The opening leads into a special chamber entirely shut off from the cavity of the mantle and from the pharynx. The walls of the chamber are lined with cilia, and it has within it, or in immediate connection with its walls, two peculiar structures. One of these is a somewhat pyriform organ which, with one end close to the orifice of the chamber, extends from this point into its cavity; it is composed of a mass of spherical bodies. The other extends over the roof of the chamber in form of a cap; it consists of two portions, one of which lies directly on the walls of the roof, and has a transversely laminated structure, which, however, disappears towards the ab-anal side of the chamber; the other is an oval mass of globular cell-like bodies and lies on the free convex surface of the laminated portion.

Here again this part of the *Cyphonautes* is in the highest degree enigmatical, and yet it is difficult not to believe that in the structures just described we have an ovary and testis with associated accessory structures.

The author observed no further fact which might tend to throw light on the ultimate destination of *Cyphonautes*, and more especially nothing which might tend to confirm the remarkable views lately published by Schneider, who believes that he has traced its devolopment into the polyzoal *Membranipora pilosa*. The structure is considerably more complicated than Schneider seems to be aware of, while the opinion of this observer that the whole of the proper *Cyphonautes* structure becomes absolutely obliterated and the body of the animal converted into an amorphous mass of cells from which the *Membranipora* becomes evolved not by a process of budding but by a differentiation of structure is so startling that notwithstanding the partial assent lately given to it by Nitsche we are compelled to wish for further confirmation of the evidently careful observations of the German zoologist.

If the ab-anal chamber described above with its associated structures really belongs to the generative system—and it is hard to say what else it can be—the view that *Cyphonautes* is a polyzoal larva is scarcely tenable.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, Aug. 19.—M. Faye in the chair. MM. Jamin and Richard read the second part of their paper on the laws of cooling, and the cooling power of gases. The authors have determined the amount of heat abstracted by a gas from a warm solid placed in its midst.—A. and P. Thenard presented a memoir on the action of ozone on indigotic sulphate and on arsenius acid. The authors find that ozone decolourises three times as much indigo as the law of equivalents would lead one to suppose, and that this reaction takes place in two well-marked periods. Two-thirds of the indigo are decolourised, in the first of these periods, almost instantaneously, and one-third in the second period after the lapse of several hours. The authors ascribe this second action to hydric peroxide (*eau oxygenée*) formed by the ozone. The authors are led to doubt whether ozone is really a triple atom molecule, or whether it is simply oxygen in which is condensed a powerful selective force. They intend to thoroughly investigate this question.—M. Daubrée reported his examination of the meteorites which fell at Lancé and at Anthon (Loir-et-Cher) on the 23rd July, 1872. The Lancé stone weighed 47 kilogrammes; the one which fell at Anthon, 12 kilometres from Lancé, was much smaller. Their structure was granular, and some of the grains acted strongly on polarised light; they were evidently portions of the same mass. Specific gravity, 3·8. Elements found: iron, cobalt, nickel, copper, sodium, sulphur, chlorine, silicon, and oxygen.—Max Marie followed on the determination of the perimeter of the region of convergence of the series of Taylor, &c.—M. Mallard read a paper on the action of silicic anhydride and analogous oxides on sodic carbonate at a high temperature.—On the combined use of morphia and chloroform during surgical operations, and on a new mode of administering the latter. M. Demarquay, the author, convinced of the great danger incurred by the combined use of these agents, has abandoned it and devoted himself to the improvement of the apparatus employed for the administration of chloroform. The apparatus in question consists of a flannel mask stretched on a wire frame; the chloroform is poured drop by drop on its surface.—Observations on a note by Prof. Respighi on the solar protuberances, by S. Tacchini. The author asserts that no dependence can be placed on the details of any drawings of the prominences except when made with a telescope of large aperture.—M. Trève, in a paper on the magnet, mentions some experiments from which he deduces that the "transformation" of a bar of soft iron into a magnet requires a mechanical work and a molecular action of a kind as yet unknown.—"On the compressibility of Air and Hydrogen at high temperature" by M. Amgat. The author asserts that up to 320° these gases follow the law of Mariotte. M. Berthelot followed, on the distribution of a base between several acids in solutions. "On the aptitude of certain gases to acquire persistent active properties under the influence of electricity" by M. Chalrier. The author finds that hydrogen when acted on by electricity possesses the power of uniting directly with the nitrogen of the air and of reducing newly precipitated oxide of silver, even after it has travelled some distance from the point where the electricity was allowed to act on it. M. G. Lechartier, in a paper on the reproduction of pyroxene and peridot, stated that he had succeeded in preparing these minerals by heating mixtures of their constituents.—M. P. Bert followed with "Experimental researches on the effects of changes of barometric pressure on the phenomena of life." In a very interesting paper of great practical importance as regards miners and divers working under great pressure, the author cited the case of an English company who in a single year lost ten divers out of twenty-four three of these died suddenly on coming to the surface, *i.e.*, at the moment of sudden release from a high pressure and seven after several months of suffering from paralysis also died. The author concludes (from a series of experiments of cats and dogs) that up to five atmospheres two or three minutes should be allowed for the pressure to decrease, above that much more time must be allowed, and at nineteen atmospheres five minutes per atmosphere at least is required. If the pressure is allowed to decrease more rapidly than this death is certain.—"Comparative researches on the absorption of Gases by the blood: estimation of Hæmoglobin," by M. N. Gréhant. The author describes a method of estimating Hæmoglobin by observing the quantity of carbonic oxide the blood will absorb. Application of Meteoric Metamorphism to the study of the black crust of grey meteorites, by M. S. Meunier.—M. A. Cheux describes a white Aurora Borealis observed at La Baumette near Angers on August 8, 1872, and says that great disturbance was observed on the sun on the morning of the 9th; he gives a view of the sun showing twenty-four spots.—Extracts from two letters from Messrs. Guiscardi and H. de Saussure relative to the late eruption of Vesuvius.—Appearance of a meteor in the department of Vienne, July 23, 1872 (extract of a letter from M. Daubrée). This was the meteor of which portions fell in the Canton of St. Amand, Loir-et-Cher, Vienne is forty kilometres distant from the places where the two portions of the meteorite fell.—M. Tellier read a note on the supersaturation of water. Water may be cooled 3° or 4° below zero in a glass vessel and still remain liquid in which state it may be violently agitated but a very sudden blow often causes its solidification. M. J. Gerard exhibited photographs of the interior of an aquarium.

August 26.—M. Faye, president.—Determination of the mutual actions of Jupiter and Saturn to serve as a base for the respective theories of the two planets, by M. Le Verrier.—In a note on the action of carbon and iron on carbonic anhydride at a high temperature, by M. Dumas, the author refutes a statement lately made by M. Durunfaut that these bodies do no not react unless hydrogen is present.—Mr. C. Peters announced the discovery of two new planets, 122 and 123. The planets are of the 11·5 and 12th magnitudes respectively.—New researches on the propyl compounds, by MM. Is. Pierre and E. Puchot.—In new experiments on spontaneous generation, by M. Donné, the author supports the well-known views of M. Pasteur.—Elementary theory of simple integrals and of their periods, by M. Max Marie.—On the physical constitution of the sun, by M. E. Vicaire. The author returns to the old theory of a comparatively cold nucleus which he regards as most probably liquid. He considers that the tremendous explosions of which the sun is the seat could not occur from the midst of a mass of dissassociated gases.—Notes were received from M. Brachet relating to the improvement of microscopes; from M. Lanale, relating to aerial navigation; from M. Clarke, relating to cholera; from M. Roussett, relative to certain questions concerning medicine.—On the spherical representation of surfaces, by M. A. Bibancour.—Letter from M. Gasparis, on a new mechanical theorem.—On ozone and hydric peroxide (*eau oxygénée*). M. F. Le Blanc sent a note relating to the paper by the Messrs. Thenard in No. 8 *Comptes Rendus*, 1872. The author states that in 1854 he discovered that ozone acted on water with the production of hydric peroxide.—Industrial employment of ozone for the destruction of the empyreumatic taste of whisky, and in the manufacture of vinegar, by M. Widemann. The author established a factory at Boston, U.S., where whisky was thus treated at the rate of 12,000 gallons per week. He also converted maize whisky into vinegar by diluting it with seven volumes of water, and then treating it in the same way.—On the divisions of a base between several acids in solution, dibasic acids, by M. Berthelot.—Action of cupric sulphate on normal urine, by M. Ramon de Luna.—M. P. Bert communicated a seventh note on the influence of change of barometric pressure on the phenomena of life.—On noctilucine, by Mr. T. L. Phipson. Noctilucine is the substance which is secreted by the various animals which are phosphorescent in the dark. The author believes that the same substance is secreted by certain plants (*Agaricus*, *Euphorbia*, &c.) and that it is also produced by the fermentation and decomposition of various vegetable and animal matters. The spectrum of this substance lies entirely between the lines E and F of the solar spectrum.—On the iodide of nitrogen, by Husson, *fils*.—M. Le Verrier presented observations of the August meteorites, from Greenwich, Lisbon, and at Volpeglino.—M. Chapelas announced, respecting the meteorites of the 8th, 9th, 10th, and 11th of August, that the mean hourly number was 33·5, a decrease of 6·4 on last year. The number for 1872 was only about one third of that for 1848.—A new communication from M. Pigeon, on the typhus of horned beasts, was submitted to the examination of M. Bouley.

PAMPHLETS RECEIVED.

ENGLISH.—The Lead and Zinc Mines of the Mendips: H. B. Woodward.—What Determines Molecular Motion, the Problem of Nature: J. Croll.—A Letter to the Marquis of Salisbury on the Public Health Bill: W. Child.—The Building and Ornamental Stones of Great Britain and Foreign Countries: E. Hull.—British Association for the Advancement of Science, Report of Committee on Science Lectures and Organisation, Past and Present.—Quarterly Magazine of the Brighton Grammar School, Part II.—Science and Art, a Sermon to the Memory of F. D. Maurice: Ll. D. Bevan.—Economy of Fuel in the Blast Furnaces for Smelting Iron: I. L. Bell.—Quarterly Weather Report of the Meteorological Office, January to March, 1871.—The Vomiting of Pregnancy: E. Munro.—On the use of the Stethoscope of Obstetrics: E. Munro.—A Puzzle in Rain and Air.—Proceedings of Geologists' Association, July.—Quarterly Journal of Education, July.—College of Physical Science, Newcastle-on-Tyne, Prospectus for Session 1872-73.—A Discussion of the Meteorology of the part of the Atlantic lying north of 30° N. lat. for the eleven days ending February 8, 1870.—Charts and Diagrams to accompany ditto.

AMERICAN AND COLONIAL.—Canadian Naturalist, July.—Indiana Journal of Medicine: T. M. Stevens, Vol. III, No. 2.—Abstract of Reports of the Surveys of the Geographical Operations of India for 1870-71.—Abstracts of Specifications of Patents (Victoria) applied for from 1854 to 1866, No. 1.—Metals: W. H. Archer.—Report of the Coalfields, Western Part of Victoria.—Reports of Surveyors and Registrars for Quarter ending March 11, 1872, Victoria.—Notes on the Post-Pliocene Geology of Canada: J. W. Dawson.—The Popular Science Monthly, Nos 1-4.—The Australian Mechanic, No. 7, July, 1872.—Eighth Report of the Board of Visitors to the Observatory, Victoria.—Bulletin of the Museum of Comparative Zoology at Harvard.—Notes on the Ornithological Reconnaissance of Kansas, Wyoming, and Utah: J. A. Allen.

FOREIGN.—Zeitschrift für Biologie, Vol. viii., No. 2.—Bulletin de la Société d' Anthropologie de Paris.—Classification de 250 matières tannantes: M. Bernardin.—Memorie della Societa degli spettroscopisti italiani.—Matériaux pour la faune Belge, 2[me] part.—Myriopodes: F. Plateau.—Öfversigt. af kongl. Vetenskaps Akademiens Forhandling, Nos. 3, 4, 7.—Atti della reale accademia dei Lincei, tom. 25, Ann. 25, 1871-72.—Verhandlungen des naturhistorischen Vereins, Riga, Vol. 1, 2, 1872.

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