class began with four students, but soon the number was as great as the rooms could conveniently accommodate, and excellent work was done in spite of many inconveniences, one of the greatest of which was the impossibility of excluding the sounds of the entertainments in the Hall. From time to time *soirées* were held, and the students informally consulted as to what additional classes they wished for. Where a demand existed, every effort was made to obtain the supply.

Then came the offer of the Commissioners to meet a subscription with an equivalent endowment, and the freehold was bought, in memory of one of the truest friends of the work, Mr. Samuel Morley. Finally, the waste space which had been occupied by dressing-rooms and stores of old scenery was cleared of its dangerous wooden staircases, a sound-proof, fire-proof wall was built to divide it from the theatre, and large convenient class-rooms were built; and on the last day of September the Morley Memorial College was opened, for working men and women; Miss Goold (the well-known head of the Queen Square College) having consented to take the office of Principal here also.

Already there are 680 students on the books. Many criticisms may be made on the arrangements, but no one can say that there is a want of life in the place. The builder's men are hardly yet out of it, and the fittings are at present of the scantiest (the result of want of funds, for the delay in passing the Commissioners' scheme through Parliament has caused unlooked-for and very embarrassing delay in the receipt of the help expected from that quarter) but the enclosed prospectus will show ample signs of life. Admission to the gymnasium, smoking, and recreation rooms can only be gained by *bonâ fide* attendance on at least one class, a rule which the Committee consider very important, and which they adopted in consequence of their experience with a club which met at one time in some of the old rooms belonging to the Hall. No new students are admitted under 17, for the simple reasons that it does not answer to mix boys and men, and that the boys are provided for by the Recreative Evening Schools Association; but there is no limit of age at the other end. When the Borough Road Polytechnic is started, the College will probably take those students who want advanced literary and scientific teaching, excluding "technological classes," for which neither space nor funds would suffice. In fact, the College will be in all probability the advanced branch of the Polytechnic. At all events, it is intended that the two institutions should play into each other's hands and avoid overlapping.

You say most truly that life develops from within. I would go further, and say that "*omne vivum ex vivo*" is as true of moral and social as it is of organic life. No institution can grow and flourish unless life has been given in its service, and this is emphatically the case with that of which we are speaking. To mention names would not interest outsiders, and to those who have watched the Hall from its very beginning, nine years ago, it is well known whose heart work as well as head work has been devoted to it and kept it alive through its troubled infancy. This it is which has drawn other workers to help in doing what one alone could never accomplish, and given spirit to the whole. They have allowed life to develop from within, watching for what was practicable instead of airing preconceived theories, and this is why so little has had to be done twice over. Help of all kinds is greatly needed, for the concern is only in its early childhood yet, but one thing is certain—whatever wants have to be supplied and defects remedied, this is *not* an "architectural white elephant." Probably that could never be true of any institution which had so much heart as well as head devoted to it, but let those who doubt come and see for themselves!

February 5. A MEMBER OF COMMITTEE.

Galls.

IN NATURE of November 28, 1889 (p. 80), Prof. G. J. Romanes speaks of galls as "unequivocal evidence of a structure occurring in one species for the exclusive benefit of another," and states that "it is obvious that natural selection cannot operate upon the plants directly." Nevertheless, there is one way in which galls may be supposed to have been evolved as beneficial—or rather, less harmful—to the plants. Every farmer is aware of the great loss to vegetation caused annually by larvæ of insects boring within the branches and twigs of trees. Now suppose that all internal plant feeders were originally borers or leaf-miners—and this is highly probable,—but that some had a tendency to cause swellings in which they fed. These latter would be less injurious to the plants, and the greater the vitality of the plants the more nourishment for them; and so by degrees the globular and other highly specialized and least harmful galls would be developed, by natural selection, for the benefit not only of the insect, but also of the plant. And known galls, which I need not here enumerate, furnish us with all the steps of this evolution. T. D. A. COCKERELL.

West Cliff, Colorado, U.S.A., January 23.

Foreign Substances attached to Crabs.

THE Compound Ascidian referred to by Dr. R. v. Lendenfeld in yesterday's NATURE (p. 317) is one of the Polyclinidæ, and probably a new species. It belongs to the genus *Atopogaster*, and is closely related to *A. informis* (*Challenger* Report, Part ii. p. 171).

I have before me now five good specimens of the crab and Ascidian (the crab in this case is *Dromia excavata*, Haswell), dredged in Port Jackson, and sent by the Australian Museum, Sydney; they measure as follows:—

Specimen.	Crab (greatest diameter). cm.	Ascidian (length, breadth, and height) cm.	cm.	cm.
A	4	10	×8	×5
B	3·5	10	×6	×5
C	2·5	8	×6	×5.5
D	2·5	6	×6	×5
E	2·5	5·5	×4·5	×3

In the largest of them the Ascidian seems to be quite twenty times the size of the crab.

I notice in these specimens that the last pair of thoracic legs in the crab, which are much larger than the preceding pair, are turned up dorsally, and are so firmly embedded and attached by their sharp claws in the test of the Ascidian that it is easier to disarticulate them than to loosen their hold.

To those who dredge much round our coasts, a crab covered with foreign substances is no unusual sight. Specimens of *Hyas* are often found so overgrown with Algæ, Sponges, Zoophytes, and Polyzoa that almost the whole of the body and legs is hidden, and the animal is scarcely recognizable except by its movements. W. A. HERDMAN.

Liverpool, February 7.

The Ten and Tenth Notation.

IT is no doubt difficult for anyone to really conceive enormously great or infinitely small quantities. This difficulty is, however, much minimized by the ten and tenth notation. Indeed, if systematically used, I believe one's mental power of estimation would be practically perfect. But is it so used? I have before me three books—I only take this as an example of what frequently occurs—in which Joule's equivalent is given is—

$$\left.\begin{array}{l} 42 \times 10^6 \\ 4{\cdot}2 \times 10^7 \\ 0{\cdot}42 \times 10^8 \end{array}\right\} \text{respectively.}$$

B. A. MUIRHEAD.

Pall Mall Club, Waterloo Place, S.W., February 8.

P.S.—The natural uniform notation, at any rate for text-books, seems obvious.

EARTH TREMORS FROM TRAINS.

AMONG the writings of those who love to speculate on the future of our planet there is probably somewhere (though we have not had time to discover it) an essay on the cosmical changes which man will be able to produce in the earth. The data for solving this problem are striking. In a few centuries man has acquired all those powers over large and solid objects represented by his knowledge of explosives, and his use of steam. Multiply the centuries, and with them the history, by convenient figures (a familiar process in this kind of problem) and there is no reason why the earth's axis of rotation should not be shifted considerably by human agency.

For the present, however, we are concerned with a more

modest inquiry—to wit, how far the railways which jar the nerves of Mr. Ruskin so terribly, are desirable neighbours for anyone who prefers the earth under his feet to be firm and steady, as it was aforetime, and as it is now sometimes in remote parts of the country on Sundays. We have all noticed, when standing near a passing train, the vibration of the ground under our feet. Though this vibration decreases as we recede from the train, and may at a distance of 50 or 100 yards become insensible to such a coarse test as the actual jarring of our body, we can understand that it may be sufficient to disturb delicate instruments at a considerable distance; and thus affect the use of instruments requiring a steady foundation. Pre-eminent among such are astronomical instruments, and it was very early in the history of railways that astronomers found themselves compelled to fight for the retention of that steadiness of ground in their neighbourhood which is of vital importance to them, and with which no human agency had previously suggested an interference. It was in 1835 that the question of taking a railway near an Observatory was first raised, in connection with the Royal Observatory, Greenwich; and an animated discussion resulted in the defeat of the railway company.

But they have several times since returned to the charge, for Greenwich has always been an attractive centre for excursions, and there are many reasons why railway companies find it continually cropping up in their schemes; indeed, it is only a few months ago that the latest application of the kind was refused by Parliament.

On June 19, 1835, the Secretary of the Admiralty wrote to the Astronomer-Royal, Mr. Pond, asking for his comments on the proposed scheme for a Greenwich-Gravesend railway, passing in a tunnel under a part of Greenwich Park, in which the Royal Observatory is situated. Mr. Pond replied that he had no experience in such matters; but "the most important observations made at the Royal Observatory are those in which the stars are seen by reflection from a horizontal surface of mercury. It appears to me highly probable, by what I have experienced from slighter causes, that the passage of heavy carriages, even at the distance of the intended tunnel, might produce sufficient tremor on this surface to destroy the accuracy of these observations." On receiving this reply, Captain Beaufort, then Hydrographer to the Admiralty, wrote to a friend, Commander Denham, asking him to make experiments near one of the few existing lines of railroad—that between Liverpool and Manchester—with a sextant and artificial horizon. After explaining the object of the experiments, he says:—"It would be childish to be guided by opinions and suggestions, when the facts can be distinctly ascertained by means of the Liverpool and Manchester Railroad, and I therefore want you to take your artificial mercury horizon to that railroad, and watch the contact of a star or the sun in altitude with a telescope when the train is passing, at two or three different distances, till you come to the outer limit of vibration, or, in other words, to the distance at which the mercury is no longer affected. After you have tried this on the surface, I wish you would then try the same experiment in the neighbourhood of the tunnel, as I presume that the results will be very different."

Commander Denham's reply is as follows:—"I find the vibration of trains of 120 tons, at a speed of 25 miles an hour, affect the mercury as far as 942 feet laterally with the rails, on the same level, and on equal substratum; but vibration perfectly ceases at 1110 feet, whilst directly over the tunnel no vibration is detectable at 95 feet distance, though quite discernible at 65 feet vertical distance. . . . I am indebted to the co-operative accommodation of the directors, who allowed trains of extra weight, and at extra speed, to pass down at night hours when the busy hum (of carting carriages and bustle) was completely suspended."

In the printed report of this correspondence the Hydrographer notes on this letter: "It is proper to remark on the above that Commander Denham's experiments depended on observations with a sextant, and that the limits of tremors in the mercury would be far more extensive if viewed by the high magnifying powers used with the mural circle."

We have quoted this case in detail not only because it was the first experiment of the kind, but because the accuracy of the results, as interpreted by the Hydrographer's note, has been confirmed by later experiments. This report was adverse to the railway company, who wished to approach within 650 feet of the Observatory; but they did not relinquish their scheme at once. They suggested various plans—of running trains at slow speeds, or stopping them altogether if the Royal Observatory signalled that an important observation was just going on, and so forth—all of which were open to the objection of looking too well on paper. Meanwhile Mr. Pond had been succeeded by Mr. (afterwards Sir George) Airy, who, in 1836 January, repeated Commander Denham's experiments in the Glebe Meadow, near the Greenwich Railway, but using a small telescope instead of a sextant. He found that "a disturbance in the clearness of the image (in mercury) was perceptible when the train was 1106 feet from the mercury, and the image was almost lost from the violence of the agitation when the train was about 700 feet from the mercury. When the train was 500 feet from the mercury it was impossible to know whether there ought to be any object visible at all."

The question was ultimately resolved into a decision upon the minimum distance from the Observatory at which a railway could be allowed; and under strong pressure, Sir George Airy was induced to define this distance as something over 700 feet; but the position to which the line was thus removed was found to bring it near other buildings, and the project was ultimately shelved. The Astronomer Royal's troubles were, however, only just commencing. In 1840 the London and Chatham Railway Company asked for leave to go through the Park; being promptly followed by a similar application from the South-Eastern Company; and he must needs repeat his experiments and protests.

His experiments in March 1846 near the Kensal Green tunnel showed that tremor was sensible in the compact clay of Kensal Green to a distance of 1700 feet, but that the tremor was very much diminished where the railway enters a tunnel. Dr. Robinson, of Armagh, made independent experiments on the Dublin and Kingstown Railway. He mounted a mural circle on an ash post driven deeply into the ground, at a distance of 1655 feet from the nearest point of the line; and found that the vibration of passing trains gradually shook the instrument away from any position in which it was clamped, so that an object would not remain bisected by the cross wires. His reflection observations were numerous, and he sums them up as follows: "On these facts it is, I presume, unnecessary to offer any comment, except the simple remark that they show clearly that, in a soil such as I have described, a train of no uncommon weight or velocity can produce, at an oblique distance of two miles, such disturbance as ought never to be tolerated in an Observatory."

Sir James South also made experiments, and concludes his report to the Admiralty thus:—"To the observations of *right ascension made by reflection*, the more immediate object of this communication, let me then entreat your Lordships' serious attention, convinced, as I am, that, did they stand *alone*, they would justify your Lordships in saying to *present* as well as to *future* railroad applicants, 'WITHIN THIS PARK STANDS THE ROYAL OBSERVATORY OF ENGLAND, AND WITHIN THIS PARK'S WALLS A RAILROAD SHALL NEVER COME.'" (The italics and capitals are as in the original.)

These strong protests had the desired effect for the time being, and it was not till 1853 that another attempt was made to bring a railway within the Park. This was by the South-Eastern Company, and being postponed for a year, was not heard of again. In 1863, however, the London, Chatham, and Dover Company proposed a line from Dulwich to Epsom passing within 700 feet of the Observatory; and the South London, Greenwich, and Woolwich Railway another passing within 600 feet. Sir George Airy was at first inclined to think that, if these railways were laid in tunnels, they might be permitted. But as facilities for making experiments had meantime increased with the multiplicity of lines, he renewed his investigations at the suggestion of the Hydrographer, and found that the protection of the tunnel was by no means established; and in other respects he had been if anything too lenient in assigning minimum distances. His conclusions from the experiments were:—

"I. It is indispensable that the railway pass through the Park in a covered tunnel.

"II. It is indispensable that its minimum distance from the transit circle of the Royal Observatory exceed 1000 feet."

The result of all these independent experiments seem to be that even with small instruments, such as a sextant or a small telescope, vibration is sensible at 1000 feet distance; and that though a tunnel may be a protection in some cases (we shall presently find reason to question this more seriously) the reasons are not sufficiently understood to enable us to predict the influence of individual tunnels. All the observations, except one of Dr. Robinson's, have reference to reflection observations; but it does not follow that these are the only observations disturbed, as is made abundantly clear by the single observation of Dr. Robinson's referred to, where the telescope was practically shaken to another position against the clamp. It is in reflection observations that the vibration is most easily discernible, but errors introduced into other observations are no less serious because they are not readily detected. Observation with mercury is a delicate test, but it is quite possible that we may very soon find even a more delicate test necessary. We are, for instance, only on the threshold of photographic experiments for which the most perfect steadiness is essential; and it is of the utmost importance to make sure that our large Observatories are so protected as to be available for such work as is gathering shape in the mists of the near future. If any mistake has been made in dealing with railway proposals, it has been that of being too lenient; firstly, from the desire to yield as far as possible in matters affecting public convenience; and, secondly, perhaps from not fully appreciating the remark of Captain Beaufort in 1835, that the results obtained with small instruments must be properly magnified for dealing with large ones. This point has been made clear by the last case we shall quote, also from the history of the Royal Observatory. Proposals for an adjacent railway were renewed, as we have said above, in 1888. It had been already noticed that the lines which had been permitted were not sufficiently remote to prevent disturbance, and accordingly experiments were now made with the transit circle itself instead of with a small instrument. An observer was stationed at the transit circle prepared for a nadir observation, and for an hour noted the times when the images were steady, when partially disturbed, and when so agitated as to prevent observation. These times were noted carefully by a standard clock to within a few seconds. Other observers were furnished with watches set to standard time, and travelling on the various lines of railway in the neighbourhood noted the exact times of stopping and starting of all trains, entries into tunnels, &c. The observations were made near midnight when other traffic was stopped. On the following day the independent records of the transit circle observer and the train observers were compared. These operations were repeated on five separate nights. The result of the series of observations may be gathered from the following extract from the Report of the Astronomer-Royal to the Board of Visitors, 1888 June 2:—

"It resulted from these experiments that trains on the Greenwich-Maze Hill Railway caused great disturbance during their passage, not only on the section between Greenwich and Maze Hill, the nearest point of which is 570 yards from the transit circle, but also on the line beyond Greenwich on the London side, and beyond Maze Hill on the Woolwich side. The distances of the Greenwich and Maze Hill Stations from the Observatory are about 970 and 670 yards respectively . . . The disturbance was very great during the passage between Greenwich and Maze Hill, the reflected image being invisible while the train was in the tunnel, at a minimum distance of 570 yards, and there was considerable disturbance during the passage of trains through the Blackheath-Charlton tunnel, at a distance of a mile, the reflected image becoming occasionally invisible."

It thus appears that the tunnels increased rather than diminished the disturbance; and that the minimum distance for insensible tremor had been considerably underestimated. But the interference with the work of the Observatory is not serious. By the vigorous action of Sir George Airy and his successor the national Observatory has been saved from the misfortunes which have befallen Paris and Berlin, where traffic has been allowed to make certain classes of observation impossible.

H. H. TURNER.

TITANOTHERIUM IN THE BRITISH MUSEUM.

TO those English zoologists who have not had the good fortune to visit the palæontological museums of the United States the huge Miocene mammals forming the family *Titanotheriidæ* have been hitherto known only by description and small-sized figures of the skull and skeleton, which, however excellent they may be, afford but a very inadequate idea of the proportions of these most remarkable Perissodactyle Ungulates. Recently, however, Prof. O. C. Marsh, of New Haven, to whose generosity our National Museum is already much indebted, has presented that institution with a beautifully executed model of the skull of one of these mighty brutes, which is now exhibited in the front palæontological gallery, below the head of the skeleton of the Kentucky mastodon. By singular good fortune the Keeper of the Geological Department of the Museum has been enabled at the same time to purchase associated examples of the teeth of another member of the family, which are placed alongside of the cast, and thus enable us to see the actual state of preservation in which the remains of these creatures are found.

The *Titanotheriidæ* were first made known to science from the evidence of specimens of the dentition described years ago by the French naturalist Pomel, by whom the name *Menodus* was proposed for their owner. Unluckily, however, this name was preoccupied by the earlier *Menodon;* and we are therefore compelled to adopt for the type member of the family the name *Titanotherium*, which is the first of the numerous terms proposed by American writers. The species of which the skull has been presented to the Museum is made by Prof. Marsh the type of a distinct genus under the name of *Brontops*. The chief distinction of this form from the type of *Brontotherium*, which seems inseparable from *Titanotherium*, appears to be the reduced number of incisors, but if writers like the Director of the Museum are right in regarding such variations in the allied group of the