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THURSDAY JANUARY 9, 1873

DEEP SPRINGS

As our contribution to a controversy which has now been going on for some weeks in the *Times*, and to which much public attention has been given, we have received Prof. Geikie's permission to print a Lesson from his forthcoming Primer of Physical Geography dealing with the subject of Deep Springs.

The facts which Prof. Geikie here summarises in so admirable a manner, taken in connection with what has already appeared in NATURE as to what one may almost call the cosmical connections of the recent rainfall, and the actual conditions of the case placed before the readers of the *Times* by Mr. Bailey Denton, should, we think, be enough to convince all that there is a science in these matters, and that the way in which Nature is in the habit of working should be at least understood, if even in only a feeble way, before a protest be entered against her.

Do we wish to continue to avail ourselves of surface springs? If so it must be remembered, first, that these are impossible without the deep springs of which Prof. Geikie speaks; secondly, that it may be roughly said, that they are normally replenished once a year, and that in some parts of England there has not been rain enough this year yet to replenish them. In the words of Mr. Denton:—

"During the summer months, from May to October, the rain which falls seldom reaches the depth of a yard. This has been clearly shown by Dickinson's records. During that period evaporation, exceeding the rainfall very considerably, draws upon the subterranean supply of water stored in the soil, and in continued drought the draught is immense. In the winter months, from October to May, when the rainfall exceeds the evaporation, the excess penetrates the earth, and having saturated the subsoil as it passes through it, the surplus descends to the springs or subterranean level to replenish the one and raise the other. To produce this super-saturation requires time, and hence it is that 'mid-winter'—*i e.* the shortest day—is reached before the deep springs and deep water-beds are augmented."

The present controversy will do lasting good if it induces, and we think it may, accurate observations of the amount of water in the deep springs in different areas in different years, and at different times of the year. It is more than possible that the late heavy rainfall is even, from the deep spring point of view, a manifestation of a higher law—or of a miracle as Mr. Babbage would have called it—that nature may not only replenish our underground cisterns every year, but vary the yearly supply, over a period of eleven years or so.

Professor Geikie's "Lesson" runs as follows:—

"In this lesson we are to follow the course of that part of the rain which sinks below ground. A little attention to the soils and rocks which form the surface of a country is enough to show that they differ greatly from each other in hardness, and in texture or grain. Some are quite loose and porous, others are tough and close-grained. They consequently differ much in the quantity of water they allow to pass through them. A bed of sand, for example, is pervious, that is, will let water sink through it readily, because the little grains of sand lie loosely together, touching each other only at some points, so as to leave empty spaces between. The water readily finds its way among these empty spaces. In fact, the sand-bed may become a kind of sponge, quite saturated with the water which has filtered down from the surface. A bed of clay, on the other hand, is impervious; it is made up of very small particles fitting closely to each other, and therefore offering resistance to the passage of water. Wherever such a bed occurs, it hinders the free passage of the water, which, unable to sink through it from above on the way down, or from below on the way up to the surface again, is kept in by the clay, and forced to find another line of escape.

"Sandy or gravelly soils are dry because the rain at once sinks through them; clay soils are wet because they retain the water, and prevent it from freely descending into the earth.

"When water from rain or melted snow sinks below the surface into the soil, or into rock, it does not remain at rest there. If you were to dig a deep hole in the ground you would soon find that the water which lies between the particles would begin to trickle out of the sides of your excavation, and gather into a pool in the bottom. If you baled the water out it would still keep oozing from the sides, and the pool would ere long be filled again. This would show you that the underground water will readily flow into any open channel which it can reach.

"Now the rocks beneath us, besides being in many cases porous in their texture, such as sandstone, are all more or less traversed with cracks—sometimes mere lines, like those of a cracked window-pane, but sometimes wide and open clefts and tunnels. These numerous channels serve as passages for the underground water. Hence, although a rock may be so hard and close-grained that water does not soak through it at all, yet if that rock is plentifully supplied with these cracks, it may allow a large quantity of water to pass through. Limestone, for example, is a very hard rock, through the grains of which water can make but little way; yet it is so full of cracks or 'joints,' as they are called, and these joints are often so wide, that they give passage to a great deal of water.

"In hilly districts, where the surface of the ground has not been brought under the plough, you will notice that many places are marshy and wet, even when the weather has long been dry. The soil everywhere around has perhaps been baked quite hard by the sun; but these places remain still wet in spite of the heat. Whence do they get their water? Plainly not directly from the air; for in that case the rest of the ground would also be damp. They get it not from above, but from below. It is oozing out of the ground: and it is this constant outcome of water from below which keeps the ground wet and marshy. In other places you will observe that the water does not merely soak through the ground, but gives rise to a little runnel of clear water. If you follow such a runnel up to its source, you will see that it comes gushing out of the ground as a Spring.

"Springs are the natural outlets for the underground water. But you ask why should this water have any outlets, and what makes it rise to the surface?

"The subjoined figure (Fig. 1) represents the way in which many rocks lie with regard to each other, and in which you would meet with them if you were to cut a long deep trench or section beneath the surface. They are arranged, as you see, in flat layers or beds. Let us suppose that *a* is a flat layer of some impervious rock, like clay, and *b* another layer of a porous material, like sand. The rain which falls on the surface of the ground, and sinks through the upper bed, will be arrested by the lower one, and made either to gather there, or find its escape along the surface of that lower bed. If a hollow or valley should have its bottom below the level of the line along which the water flows, springs will gush out along the sides of the valley, as shown at *s s* in the woodcut. The line of escape may be either, as in this case, the junction between two different kinds of rock, or some of the numerous joints already referred to. Whatever it be, the water cannot help flow-

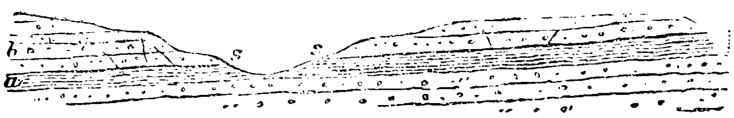

Fig. 1.—Origin of Surface Springs.

ing onward and downward, as long as there is any passage by which it can find its way; and the rocks underneath are so full of cracks that it has no difficulty in doing so.

"But it must happen that a great deal of the underground water descends far below the level of the valleys, and even below the level of the sea. And yet, though it should descend for several miles, it comes at last to the surface again. To realise clearly how this takes place, let us follow a particular drop of water from the time when it sinks into the earth as rain to the time when, after a long journeying up and down in the bowels of the earth, it once more reaches the surface. It soaks through the soil together with other drops, and joins some feeble

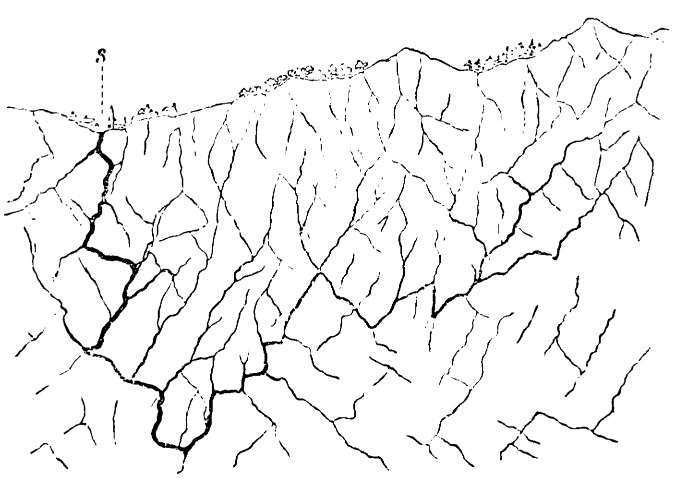

Fig. 2.—Section of part of a district to show the origin of deep-seated Springs. The Numerous joints in the rocks lead the water down into a main channel, by which it re-ascends to the surface as a spring at *s*.

trickle, or some more ample flow of water, which works its way through crevices and tunnels of the rocks. It sinks in this way to perhaps a depth of several thousand feet until it reaches some rock through which it cannot readily make further way. All this while it has been followed by other drops, coursing after it through its winding passage down to the same barrier at the bottom. The union of all these drops forms an accumulation of water, which is continually pressed by what is descending from the surface. Unable to work its way downward, the pent-up water must try to find escape in some other direction. By the pressure from above it is driven through other cracks and passages, winding up and down until at last it comes to the surface again. It breaks out there as a gushing spring (see Physics Primer, Art. 23).

"Thus each of the numerous springs which issue out of the ground is a proof that there is a circulation of water underneath, as well as upon the surface of the land. But besides these natural outlets, other proofs are afforded by the artificial openings made in the earth. Holes, called Wells, are actually dug to catch this water. Mines, pits, quarries, and deep excavations of any kind, are usually troubled with it, and need to be kept dry by having it pumped out."

It is a satisfaction to think that, as Science gets more infused into our general education, such a question as the one to which attention is now directed will not be mooted until its scientific bearings are understood; for after all the question of deep springs is only one of the scientific points involved in the controversy.

SHELLEY'S BIRDS OF EGYPT

A Handbook to the Birds of Egypt. By G. E. Shelley, F.G.S., F.Z.S., &c. 1 vol. 8vo, with 14 coloured plates. (London: Van Voorst, 1872.)

MANY travellers who go "up the Nile" during the winter months, devote the leisure, which would otherwise hang somewhat heavily on their hands, to making a collection of birds. The boating trip usual on these occasions is, as Captain Shelley observes, admirably adapted for this purpose, "as there is much time left on hand while the vessel is delayed by adverse winds; and even at other times progress is frequently not so rapid as to prevent the traveller from keeping pace with the boat, if he chooses to land for the sake of sport, which may generally be obtained on the banks of the river."

To such persons Captain Shelley's volume will be most acceptable, as there was previously no single work that contained sufficient information to enable them to determine the names of the birds met with on the Nile. Rüppell's "Systematische Uebersicht" gives a complete list of all the species known to occur in Egypt at the time of its publication. But besides being now rather out of date, Rüppell's volume does not include descriptions of most of the common birds, and requires to be supplemented by several other works hardly adapted for a traveller's library. Captain Shelley's handy volume contains a sufficiently full account of all the Egyptian birds hitherto recorded, and is therefore far more convenient for use during a tour up the Nile, though other works will be required on the return home, to enable some of the more closely allied species to be certainly discriminated.

As limits of the "Egyptian district," of which he treats, Captain Shelley takes the Mediterranean on the north, and the second Nile cataract on the south, with the Arabian and Libyan deserts to the east and west. Within this area about 350 species of birds are met with, of each of which a short description is given, together with remarks upon the time of its occurrence, habits, and other peculiarities. The greater number of the birds of Egypt are well-known European forms, but there is a considerable admixture of Oriental and African species. In the latter category we may notice the beautiful little sun-bird, *Nectarinia metallica*, of which the portrait forms the frontispiece to the volume. Captain Shelley met with it near Kalabshee in Nubia, where it is tolerably plentiful in April, but has "no doubt that it occasionally descends below the first cataract," as he noticed several specimens within twenty miles of Philæ. Other tropical forms which intrude into the Nile district are the yellow-vented Bulbul (*Pycnonotus arsinoe*), the Egyptian Bush-babbler (*Crateropus acaciæ*), the Bifasicated Lark (*Certhilauda desertorum*), and two other species of Bee-eater, besides the *Merops apiaster* which visits Europe. The most abundant groups among the Passerine birds of Egypt are, perhaps the Larks and the Stonechats, of both of which numerous forms occur along the Nile banks. Nearly all the European *Sylviidæ* are likewise found in Egypt, either all the year round, or in winter during their southern migration. The list of birds of prey is also numerous, and many of the eagles and hawks are said to be individually very abundant. In fact, Egypt must be pronounced to be quite a paradise for an ornithologist who wishes to "take it easy," and to collect a number of rare and interesting species without going far from home, or endangering his health in the forests of the tropics.

Whilst allowing Captain Shelley great credit for the general way in which he has performed his task, we must be permitted to point out several "heresies" in his scientific arrangement, which, however, are manifestly owing rather to carelessness than to ignorance. The Andalusian Hempode (*Turnix sylvatica*) certainly cannot be correctly referred to the Tetraonidæ—though Captain Shelley might find precedents for such a course—nor the Ibises, Storks, and Cranes to the Charadriidæ, for which, on the other hand, no sort of precedent will be found. It is also new to us to see the Rails and Crakes arranged in the order "Anseres" in the same family (!) as the Ducks and Geese, and the Gulls and Terns united to the Pelicans. Here, we suspect, our author must have got into some muddle in "making up his sheets." On the other hand, great praise must be awarded to the illustrations, which are obviously from the facile pencil of Mr. Keulemans, and represent some of the most novel and attractive species. We could only have wished that a map had been added, with all the localities spoken of by the author marked on it. In these days no work referring to geographical zoology can be deemed complete without a map to it.

OUR BOOK SHELF

A Manual of Chemistry, Theoretical and Practical. By George Fownes, F.R.S. Eleventh edition, revised and corrected by Henry Watts, B.A., F.R.S. (London: J. and A. Churchill, 1873.)

We have received the eleventh edition of Fowne's Manual of Chemistry. The great popularity of this famous chemical text-book has already necessitated the publication of this edition, although the last was only issued in 1868. Since that time great progress has been made in the science, and we must thank Mr. Watts for having made this edition fully equal to the present educational requirements of chemistry. In order to prevent the increase of the present volume beyond the slightly unwieldy size attained by the last, the editor has somewhat shortened the sections of the work relating to physics. This is by no means to be regretted, as admirable manuals on this subject are now within the reach of all.

Another improvement has been effected by the introduction of a chapter giving the most important points of the received theories of chemical combination and the atomic hypothesis. By thus giving the student some idea of the theoretical portions of the science at an early period, it becomes possible to make him acquainted with the use of formulæ much sooner than would have been the case had the original plan of the author been adhered to. A chromolithograph of various spectra forms the frontispiece, but we regret to find that the chapter on spectrum analysis is somewhat more meagre than might have been expected. We notice that the size of the page and of the type has been increased, and the whole appearance of the book improved, but the old woodcuts still do duty; this is a great pity, the French and German manuals very far surpass any of ours in this respect. Why should this be so? There can be no doubt that well executed sketches of apparatus are of great use to students in showing them how to do their work with neatness, and to none is this more important than to the large class of students now rising, who have to study the science without ever having the chance of seeing a well appointed laboratory or a good manipulator. R. J. F.

Elements of Zoology. By A. Wilson. (Edinburgh: Adam and Charles Black.)

Very high authorities have lately come to the conclusion—and the character of this book and of others like it lately published in Edinburgh confirm that conclusion—that it is not desirable to teach the *elements* of zoology at all. You cannot in a volume of 600 pages, illustrated with 150 woodcuts, really give an adequate account of the animal kingdom. Nothing less extensive than "Cuvier's Regne Animal," or "Bronn's Thierreich" can deal with the subject. The very essence of Zoology lies in a wide survey of forms which cannot possibly be illustrated in a cheap book. A museum, dissecting rooms, microscopes, special monographs, are necessary for the study of Zoology, and it is useless to give a hurried account of the larger groups into which animals are divisible as an introduction to it. We do not want such elements of Zoology taught in schools and junior classes—elements of which the teacher himself has probably no real knowledge from the study of nature—elements which it is clear that Mr. Wilson has put together from his notes of Prof. Allman's course, and from Prof. Huxley's publications—but which he knows but little of from his own observation of nature. What can be taught in place of such elements of Zoology is the ground-work of Biology; and this teaching designed to give a correct appreciation of the phenomena of life—not an exhaustive survey of all the forms and peculiarities of animal life—is a much more practicable thing for educational purposes and extra-university classes. Special types of both animal and vegetable life are taken, which the teacher has himself studied, and which he can place in quantity in the hands of his pupils for like study. Real scientific training is thus promoted, and books which shall help this form of teaching are needed. On the other hand, books like Mr. Wilson's do a great deal of harm. They put zoology altogether out of the category of natural sciences, making it a subject of hearsay, and when written by men who are not themselves actively working zoologists, are simply mechanical epitomes or analyses of other men's work. Moreover, Mr. Wilson does not appear to possess qualifications for writing such an epitome, for he is not acquainted with French and German work.

Not to enter into the specific inaccuracies of this book, we may simply mention that it is not up to the times. It is ten or fifteen years behind its day throughout, the reason of which is obvious when we find that it is an abridgment of works published about fifteen years since. Fifteen years means a great deal in Zoology, the most actively advancing of any science at the present time, since Darwin's theory has stimulated research in it in all directions. There is no recognition in this book of Darwinism, no proper account of the Protozoa; development throughout is inadequately sketched, or in most cases altogether ignored. Geographical distribution might never have been studied during these twenty years.

We cannot view without great dissatisfaction the production of educational books like the present one on a branch of science in which the author has not worked himself, and in the progress of which he is not sufficiently interested to lead him to keep up with some of its most important advances. It is an injury to the study itself, and an injustice to those seriously engaged in that study.

LETTERS TO THE EDITOR

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

Dr. Bastian's Experiments on the Beginnings of Life

In every experimental science it is of great importance that the methods by which leading facts can be best demonstrated, should be as clearly defined and as widely known as possible. This is particularly true as regards physiology, a science of which the experimental basis is as yet imperfect. All experiments by which a certainty can be shown to exist where there was before a doubt, serve as foundation stones. It is well worth while taking some pains to lay them properly.

Your readers are aware that Dr. Bastian, in his work on the Beginnings of Life, has asserted that in certain infusions the "lower organisms" come into existence under conditions which have been generally admitted to exclude the possibility of the pre-existence of living germs. It is also well known that these experimental results are disputed.

Not long ago I witnessed the opening of a number of experimental flasks charged many months ago by a friend of mine with infusions supposed to be similar to those recommended by Dr. Bastian. The flasks had been boiled and closed hermetically according to Dr. Bastian's method. Finding on careful microscopical examination that the contents of the flasks contained no living organisms, I charged calcined tubes with the liquids, sealed them hermetically, and forwarded them to Dr. Bastian. When I next saw him he pointed out that two of the three liquids used were not those which he had recommended, that if the infusions had been properly prepared, there would not have been any necessity for keeping them many months before examination, that his results with organic infusions were obtained after a few days, and that they were generally of a most unmistakeable nature. To satisfy my doubts on the subject he most kindly offered to repeat his experiments relating to the production of living organisms in infusions of hay and turnip in my presence. To this proposal (although I have hitherto taken no part in the controversy relating to spontaneous generation, and do not intend to take any) I gladly acceded, at the same time engaging to publish the results without delay.

Fifteen experiments were made. They were in three series, the dates of which were respectively, Dec. 14, Dec. 20, and Dec. 27.

First Series—(Dec. 14th.)

Two infusions were employed, an infusion of turnip, in making which both the rind and the central part were used, and an infusion of hay. Both had been prepared the same day a short time before they were used.

The turnip infusion, of which the specific gravity was 1012, and the reaction distinctly acid, was divided into two parts, of which one was neutralised with liquor potassæ. Four retorts, each capable of holding, when half full, a little over an ounce of liquid, having been prepared, two were charged with neutral infusion, the other two with unneutralised infusion. A small quantity of pounded cheese was then added to one of each pair. A fifth retort was charged with unneutralised infusion diluted with its bulk of water. As soon as each retort was charged, the open end of its beak was heated in the blowpipe flame and drawn out. The drawn-out part was then severed, and the retort boiled over a Bunsen's burner, after which it was kept in a state of active ebullition for five minutes. During the boiling, some of the liquid was frequently ejected from the almost capillary orifice of the retort. At the end of the period named it was closed by the blowpipe flame, care being taken to continue the ebullition to the last. The success of the operation was ascertained in each instance by observing that, by wetting the upper part of the retort, the ebullition was renewed.

Three similar retorts were charged with the hay infusion, the specific gravity of which was 1005, and the reaction neutral. Of these, one contained the infusion diluted with its bulk of distilled water, the others being charged with infusion to which no addition had been made. These three retorts were closed, after boiling, in exactly the same way as those containing turnip infusion. The eight retorts were placed, immediately after their preparation, in a water-bath, which was kept at a temperature of about 30° C.

We met to examine the flasks on December 17, just three days after their preparation, Dr. Bastian having previously expressed his anticipation that the infusions of turnip with cheese, whether neutralised or not, would be found by that time to contain multitudes of Bacteria, and that the other two undiluted turnip infusions would exhibit obvious changes. In the hay infusions, he expected that the process would not advance so rapidly; the diluted infusions, he thought, would remain permanently unaltered. The results in each case were as follows:—

(*a.*) *Neutral turnip infusion with cheese.*—On the 16th I observed that the liquid had become turbid; on the 17th the turbidity was very obvious. Before opening the retort it was ascertained that when the blow-pipe flame was directed against the tube the heated part was drawn inwards, and further, that when the retort was inclined with its bulb upwards, so as to allow the liquid to rush against the closed end, a characteristic water hammer sound was produced. On breaking the point, air rushed in with a tolerably loud sound; the liquid was crowded with moderately sized Bacteria, which exhibited active progressive movements. There were also Leptothrix filaments.

(*b.*) *Unneutralised turnip infusion with cheese.*—On the 17th, the retort having been tested in the same way as before with similar results, was opened. It contained no living forms.

(*c.*) *Neutral turnip infusion without cheese.*—On the 17th this liquid exhibited no marked change. It was finally examined on the 31st, and found to be still unaltered.

(*d.*) *Unneutralised turnip infusion without cheese.*—Up to December 31 no change had taken place in this infusion.

(*e.*) *Undiluted hay infusion.*—The infusion was slightly turbid on the 17th; on the 20th the turbidity was more marked, and before the flask was opened, the water-hammer sound and other evidence showed that it was entire. The liquid was found to be full of minute but very active Bacteria, and contained numerous colonies of spheroids undergoing transformation into Bacteria. There were also Leptothrix filaments.

(*f.*) *The same.*—This infusion was examined on the same day. It had become turbid at about the same time as the last infusion, though to a less extent. It was distinctly acid. A drop of this fluid contained few Bacteria as compared with *e*.

(*g.*) *Diluted hay infusion.*—On the 20th it was discovered that the retort was accidentally cracked. The liquid was swarming with Bacteria, and possessed an offensive smell. On account of the crack, Dr. Bastian regarded the experiment as futile.

(*h.*) *Diluted turnip infusion.*—This liquid remained unchanged.

Second Series—(Dec. 20th.)

The purpose of this series was to ascertain whether the irregularities of the results with the turnip infusions in the first series, as compared with Dr. Bastian's already recorded results, were due to the fact that the material used consisted partly of rind. Dr. Bastian thought that this might be the case, and accordingly another infusion was prepared in which no rind was employed. As before, the fresh acid infusion of turnip was divided into two parts, one of which was neutralised by liquor potassæ. Of four retorts, three were charged with unneutralised liquid, the fourth with neutral. Of the three, two were treated with cheese; to the third no addition was made. They were prepared in every respect as before. In each case the drawing-in of the glass in the blowpipe flame was again noticed before the neck of the retort was broken.

(*a.*) *Unneutralised infusion with cheese.*—This infusion showed opalescence, even after twenty-four hours. On the 23rd it had become decidedly turbid, and was opened. The liquid was fœtid, and its reaction acid. It swarmed with Bacteria.

(*b.*) *The same.*—The retort was opened on the 31st, its contents having shown a slight turbidity for several days previously. The liquid was slightly fœtid, and it contained characteristic Bacteria, which, however, were few in number.

(*c.*) *Neutral infusion without cheese.*—The retort was opened on Dec. 31, the fluid having been slightly turbid for several days. The liquid was acid, and slightly fœtid, but still retained the odour of turnip. A drop contained a few Bacteria, about 0·003 mm. in length, which exhibited oscillatory movements.

(*d.*) *Unneutralised infusion without cheese.*—The liquid contained a white mass which lay at the bottom, and was so tenacious that it could be drawn out into strings with needles. This consisted entirely of Bacteria and Leptothrix, embedded in a hyaline matrix. There were also Bacteria in the liquid.

THIRD SERIES—(Dec 27th.)

It appeared to me desirable to ascertain whether the condition of the internal surface of the glass vessels exercised any influence on the result. I therefore heated two retorts to 250° C., keeping them at that temperature for half an hour, and closed them while hot in the blow-pipe flame. These Dr. Bastian charged by breaking off their points under the surface of a neutral infusion of turnip with cheese, freshly prepared for the purpose, without employing any of the rind. The retorts were boiled and sealed in the same way as before, excepting that whereas one was boiled only five minutes the other was boiled ten minutes. The specific gravity of the infusion used was 1013. A third uncalcined retort was charged with some of the same infusion containing no cheese. This was also boiled for ten minutes.

I was out of town from the 28th to the 30th, and therefore did not examine the retorts until the 31st. Dr. Bastian informed me that on the 28th, twenty-one hours after preparation, the liquids in both the calcined retorts were distinctly turbid, the temperature of the water bath being 32° C.: and that sixty-six hours after preparation, whilst the turbidity was much more marked, each flask also contained what appeared to be a "pellicle," which had formed and sunk. At this period the fluid in the third flask had also become very decidedly turbid.

(*a.*) *Neutral turnip infusion with cheese in calcined retort, boiled ten minutes.*—The retort having been tested in the way previously described, was opened on the 31st. The liquid was very fœtid, had an acid reaction, and contained much scum. It was found to be full of Bacteria, whilst Leptothrix existed in abundance in portions of the scum, together with granules of various sizes which refracted light strongly.

(*b.*) *The same boiled five minutes.*—The state of the liquid was the same as that just described.

(*c.*) *Neutral infusion without cheese, boiled ten minutes—retort not calcined.*—In this liquid the rods and filaments were much less numerous. In other respects its characters were the same.

In each case before opening the retort it was again observed that a portion of its neck became drawn in when exposed to the blow-pipe flame.

As regards the results of the foregoing experiments, it is unnecessary for me to say anything as to their bearing on the question of heterogenesis. The subject has already been frequently discussed in your columns.

The accuracy of Dr. Bastian's statements of fact, with reference to the particular experiments now under consideration, has been publicly questioned. I myself doubted it, and expressed my doubts, if not publicly, at least in conversation. I am content to have established—at all events to my own satisfaction—that, by following Dr. Bastian's directions, infusions can be prepared which are not deprived, by an ebullition of from five to ten minutes, of the faculty of undergoing those chemical changes which are characterised by the presence of swarms of Bacteria, and that the development of these organisms can proceed with the greatest activity in hermetically-sealed glass vessels, from which almost the whole of the air has been expelled by boiling.

J. BURDON SANDERSON

University College, Jan. 1

The Recent Star-shower at Sea

IN case no other account should reach you of a meteoric shower witnessed by the officers and military passengers of H. M. troopship *Tamar* on the night of Wednesday, November 27, 1872, I send notes collected from several accounts.

The vessel was at the time about 7° south and 4° west of the Bermudas, in longitude 68° 50′ W., latitude 25° 30′ N. Between 8 and 10 P.M. by one witness, between 10 and 12 P.M. by another, that is, between 12h. and 16h. Greenwich mean time, there was a nearly uninterrupted succession of shooting stars—from all parts of the sky, says one, from about E.N.E. to W.S.W., says another. The gentleman who gives the earlier hour estimates their number as from 25 to 50 per minute; the gentleman who gives the later at about 3 in 2 minutes. They were not counted or accurately observed by any one, but this discrepancy perhaps justifies the belief that the thickest part of the stream was passed through by the earth at the earlier hour. Sunset would have been soon after 5; thus it was dark with no moon before the earliest hour named.

I cannot learn that they were seen in Bermuda; but the weather was cloudy.

J. H. L.

Bermuda, Dec. 17, 1872

Curious Auroral Phenomenon

ON the nights of the 4th and 5th of this month a curious phenomenon, presenting much resemblance to an aurora borealis, was noticed here.

It had the character of a faint, steady light, rather red than yellow, extending over the horizon, which here in that direction is bounded by the sea-line, from N.W to N.N.E.; while underneath it, that is between it and the horizon, was a rim of dark, smoke-like appearance, such as I have more than once seen in undoubted auroras. The smoky line occupied to a height of about three degrees above the horizon; the light to ten or twelve at most. On both nights it became visible about 9 P.M., and disappeared shortly after 11 P.M.

My house being situated rather more than 300 ft. above the sea and commanding a perfectly open view over it, I had a good opportunity of noticing this appearance: which was also observed and commented on by several other inhabitants of the town. On the night of the 6th I thought I could distinguish something of the kind, but the increasing light of the moon and a sea-fog coming on, rendered the fact uncertain.

The barometer was high, 30″ 20″, the wind slight and from the east, the weather cool.

It may be worth adding that the water of the Black Sea being but slightly salt, its phosphorescent phenomena are proportionally insignificant. Hence I do not think that the light in question could have been any way reflected from the sea-surface.

No electrometer or instrument of the kind exists at Trebizond, but the uncomfortable sensations of which many people complained, and, I may add, the abundant sparks from my Tom's back—I ruffled it by way of trial on purpose—seemed to imply considerable electric tension in the atmosphere at the time. The weather was also remarkably dry.

Trebizond, Dec. 15, 1872 W. GIFFORD PALGRAVE

The Spectrum of the Aurora and of the Zodiacal Light

UPON a perusal of the chapter in Dr. Schellen's "Spectrum Analysis," specially bearing on the above subjects, I have been led to think—firstly, that our present knowledge of these spectra is far from complete; and secondly, that so far as such knowledge extends, it hardly warrants some of the conclusions arrived at in Dr. Schellen's work. To test the question of the aurora, I have collected, chiefly from the pages of NATURE, a set of observations (excluding a few which gave only rough results), and have arranged them under the heads of the several lines, so that these and their characteristics may be seen at a glance, and the observations compared; and from these observations I deduce the following remarks:—

1. That the full spectrum of the aurora consists of seven bright lines or bands and a faint diffused spectrum.
2. That two (perhaps three) of these lines are sharp and well defined, while the others are more or less nebulous. (As Lord Lindsay notes one of the lines to be sharp on one side and nebulous on the other, it is probable that this, and perhaps others of the nebulous lines, would resolve into groups of lines under higher instrumental power.)
3. That the red line (which seems to have been actually positioned by two observers only) is not found to coincide with the spectrum of any known substance or gas. (*But see next note.*)
4. That the yellow-green aurora line, and perhaps two other lines, according to one observer, coincide with lines of oxygen; while two lines, according to other observers, either fall very near to, or actually coincide with, F and G hydrogen, and that to this extent the axiom of Zöllner, that the spectrum of the aurora does not agree with any of the known spectra of the gases of our atmosphere, is challenged.
6. That Zöllner's theory of the lines or bands in the blue being remains of a continuous spectrum broken up by dark absorption bands, is hardly supported by the other observers.
7. That the aurora spectrum is probably a mixed one, and that the red and yellow-green lines are independent spectra; as also may possibly be the corona line and the continuous spectrum crossed with the fainter lines.
8. That the discrepancies in the observations recorded are considerable, and that all the lines (except, perhaps, Angström's), and specially the red one, require further examination to confirm their position.

And this last proposition I venture to commend to the attention of your spectroscopic correspondents during this winter.

The zodiacal light will also undeniably bear further investigation. The evidence at present seems to strongly incline to the presence of a faint continuous spectrum only. Webb, Backhouse, and Pringle are positive in their observations as to this; and, on the other hand, the bright green line referred to by Dr. Schellen, as seen by Angström and Zöllner *in all parts of the sky* can, as Pringle has well noticed, hardly be assumed to belong conclusively to the zodiacal light, but rather to some faint accompanying aurora. I am not aware whether the zodiacal light and the aurora have been examined with a polariscope. The light, though faint, might, I imagine, be tested with a Nicol's prism and Savart bands. An observation of the zodiacal light in the spring showed me its faint rose-red tint very distinctly, although I was not at that time aware that this tint was characteristic.

AURORA SPECTRUM

No. 1.—*A Line in the Red between C and D*

OBSERVER.	REMARKS.
T. F. (Torquay).	Strong, intermediate in colour and position to lithium and calcium.
J. R. C.	Like lithium line, but duskier; well seen in Browning's miniature spectroscope; sharp and well defined.
BARKER.	Almost equidistant between C and D; wave-length, 623* (C and D being respectively 656 and 589); sharp and well defined; brightness 3 (counting from 1 as brightest).
PROCTOR.	At 24; Hα being 18, and Na 32. Does not coincide with any other line observer has seen.
PIAZZI SMYTH.	Between sodium and lithium, but nearer the latter. Estimated at W.L. 6350.
BACKHOUSE.	Seen in eight auroras, out of thirty-four observed.
ZÖLLNER. (Schellen.)	More refrangible than Hα; possibly lies near the dark telluric lines A; wave-length, 6,279 (Angström).

* A line of nitrogen in the air spectrum seems to lie very close to this position, and if other lines lie so near to, or coincide with, those of oxygen and hydrogen, it would appear not unreasonable, until further evidence is obtained, to conjecture that the Aurora Spectrum may be wholly or in part an air spectrum modified by temperature pressure.—J. R. C.

No. 2.—*A Line in the Yellow Green between D and E (principal auroral line)*

T. F. (Torquay).	Strong; pale yellow near D.
J. R. C.	Sharp and well defined; like principal line in nebulæ, but brighter; a peculiar flickering noticed in the line during the displays of Oct. 1870 and Feb. 1872.
ALVAN CLARK, JUN.	Wave-length, 569. (Probably an error for 559.—J. R. C.)
BARKER.	Wave-length, 562; sharp and well defined; brightness, 1.
PROCTOR.	At 41 (Na being 32); nebulous; absolutely coincident with a line in a lumière tube attributed to oxygen.
LORD LINDSAY.	Sharp and well defined; visible with very narrow slit.
HERSCHEL.	Within a few units of Kirchhoff's 1255; a peculiar flickering, and frequent changes of brightness.
PIAZZI SMYTH.	Over citron acetylene, at W.L. 5579.
SCHMIDT. (Schellen.)	Varied much in intensity.
ZÖLLNER. (Schellen.)	Brilliant in all parts of the aurora.

No. 3.—*A Line in the Green near E (corona line?)*

ALVAN CLARK, JUN.	At 532; assumed to be 531·6 (corona line).
WINLOCK. (Schellen.)	Notes three lines in the aurora as coincident with corona lines.
LORD LINDSAY.	Near E.; woolly at the edges, but rather sharp in centre; at or near 1474 of the corona.
BACKHOUSE.	Once only, at 532.

No. 4.—*A Line in the Green at or near b*

ELGER.	Very faint; half way between principal auroral line and F.
BARKER.	At 517. (Assumed to be 520.—Winlock.) Nebulous; brightness, 5.
LORD LINDSAY.	A faint band coincident with *b*, and extending equally on both sides of it.
PROCTOR.	A faint band at 57, Na being 32 and Hβ 75, coincident with a line (of oxygen?) in lumière tube.

No. 5.—*A Line in the Green between b and F*

BARKER.	At 502; brightness, 2; conjectured to coincide with a line in the chromosphere.
BACKHOUSE.	Mentions a faint band seen in five auroras out of thirty-eight at 500 or 510 (501? —J. R. C.)

No. 6.—*A Line in the Green-Blue at or near F*

ELGER.	Faint and nebulous.
ALVAN CLARK, JUN.	At 485; assumed to be 486 F hydrogen.
BARKER.	At 482; assumed to be 485 of Alvan Clark, jun.
PROCTOR.	At 81; more refrangible than Hβ (75).
LORD LINDSAY.	Very slightly more refrangible than F; side towards D sharp and well defined; other side nebulous.

No. 7.—*Line in the Indigo at or near G*

ALVAN CLARK, JUN.	At 435; assumed to be 434 G hydrogen.
PROCTOR.	At 121; *more* refrangible than Hγ (114); coincident with a line (of oxygen?) in lumière tube. Probably there is some error here; this line as positioned by Lord Lindsay and Alvan Clark, jun., being slightly] *less* refrangible than G.—J. R. C.
LORD LINDSAY.	Slightly less refrangible than G; a broad, ill-defined band, seen only with a wide slit.

The continuous Spectrum

T. F. (Torquay).	Faint from about D to beyond F.
FLÖGEL. (Schellen).	Faint green reaching from aurora line to F.
SCHMIDT. (Schellen.)	From aurora line to F; frequently resolved into three bright lines.
ZÖLLNER. (Schellen.)	Considers the bright lines or bands Nos. 4, 6, and 7 to be a continuous spectrum broken up by dark absorption bands.

Guildford, Nov. 9 J. RAND CAPRON

Ocean Rainfall

WITH reference to Mr. Miller's note (NATURE, vol. vii. p. 123), I think it may be desirable to point out that a good many steps have been taken in the direction he suggests. As I believe Mr. Miller is a reader of "British Rainfall," he will probably hardly need to be reminded of the article on "Ocean Rainfall," by Mr. F. Gaster in the volume for 1866, wherein tables of the *prevalence* of rain in the North and South Atlantic and North Pacific Oceans are given in considerable detail. The determination of the amount is a far more difficult matter for a number of reasons, which would require much space fully to explain, and I am not at all surprised at the feat being considered "impossible;" but the use of that word is becoming restricted. At the British Association meeting at Brighton, Mr. W. T. Black was kind enough to show me a rain gauge which he had had constructed somewhat on the plan described by him in the *Journal of the Scottish Meteorological Society* for January 1870, and which he intended should make a few voyages on purpose to test.

With respect to gauges on lightships, I may state that at my suggestion the Elder Brethren of the Trinity House allowed a gauge to be placed upon the *Nore* lightship in the autumn of 1865. It was carefully observed by the officers on board for about two years, and the returns were compared with simultaneous records kept at Sheerness on the Kentish, and Shoeburyness on the Essex coast. I cannot say that I was satisfied with the results, which were principally vitiated by spray and wind. The gauge was bolted rigidly to a post on the deck of the vessel, as I then thought this preferable to the incessant oscillations which would result from the employment of gimbals

Considering the sources of inaccuracy attaching to the measurement of rainfall at sea, and the fact that, so far as I am aware, lightships are seldom more than ten or twenty miles from land, I think that there are few cases in which they could render valuable aid.

As to the *Challenger* I know nothing; but I do know that it was the joint resolution of Mr. Black and myself each and both to do what we could towards obtaining quantitative records of the rainfall of the North Atlantic, and when last I heard from him there were prospects of partial success. Only partial because we do not hope or expect to ascertain the true fall, but merely the relative fall in different zones, or portions of the ocean.

Camden Square, London G. J. SYMONS

INTRODUCTORY LECTURE OF THE MURCHISON CHAIR OF GEOLOGY AT EDINBURGH, SESSION 1872-3 *

II.

MUCH has recently been said (so much, indeed, that the subject begins to get somewhat wearisome) regarding the necessity for wide-spread scientific instruction to enable our artisans to compete with the advancing industry of foreign countries. Technical education has become a kind of political cry, like the county franchise or women's electoral disabilities. We hear, continually, too, of the need for a more special training in science for such professional pursuits as those of the engineer and the military officer, or of the men who devote themselves to the task of geographical discovery. Far be it from me to say one word that would seem to imply an undervaluing of such practical applications of science. Most heartily do I wish that a technical school were established in every great town in the country, and that every man whose pursuits in life might call for the aid of science, should have the means of obtaining sound practical instruction in those branches likely to be of service to him.

But I cannot believe that such utilitarian views, important though they undoubtedly are, set before us the true place which science ought to hold, and which I am convinced it will one day hold in the general system of education in this country. Scientific culture is something more than a weapon to help us in the keen warfare of trade and commerce. It is, in truth, itself a noble form of education, filling a place which can be filled by none other, and without which no modern culture of the higher type can now rightly claim to be regarded as liberal.

It is this aspect of the subject which I seek to impress upon your minds to-day. I do so the more readily since it seems to me that your presence as members of this voluntary class is a token that you recognise with me the desirability of adding to the traditional methods of education. The matters which will come to be dealt with here lie outside of the ordinary curriculum of study. Yet they form part of that wider field which must ere long be conjoined with the older territories as the domain now to be required for higher culture.

Apart altogether from any practical application to be made of a scientific training for the active business of life, such a training seems to me to deserve and require a place in our ordinary system of education on several grounds, of which I shall at present notice only two—firstly, because it trains the observing faculty; and, secondly, because it stimulates the imaginative faculty.

I. Taking the lowest view of the case, it will not be denied that a habit of quick and accurate observation is one of the most advantageous powers with which a man or woman can be equipped. Such a habit often makes all the difference between a successful and an unsuccessful career. In point of actual hard-thinking power a man may be greatly superior to his fellows, but this power is not enough of itself alone to ensure success in the battle of life. Much must ever depend on the rapidity and shrewdness with which passing events are noted and provided for; or, in other words, the care with which the observing faculty is cultivated as well as the judgment.

But beyond and above such considerations we cannot doubt that the observing spirit carries about with it a multiplied power of enjoyment—so multiplied, indeed, that, placed beside the unobserving spirit, it seems almost to have been gifted with another sense. A well-trained power of observation never suffers its possessor to feel wholly alone. Even out of the most solitary scenes it can gather pleasant companionship, and amid the ordinary monotonous routine of life it finds recreation where, in its absence, men are apt to encounter only dulness. The story of our childhood—"Eyes and no Eyes"—has in this respect a significance for people of all ages as well as for schoolboys.

If you think of it you will probably find that what we ordinarily term *common sense* springs in no small measure out of this habit of observation. A man who is wont to keep his eyes open and take note of the changes continually going on around him, both among men and things, is more likely to acquire just views of the business of life than a man who takes notice only of what forces itself upon his attention.

From the moment of our birth we are surrounded by

* Continued from p. 165.

phenomena which demand our attention, and many of which will brook no neglect. We learn what heat is, not by the instruction of mother or nurse, but by the memorable experience of scalded tongue or burnt finger. The idea of distance grows upon us as our infant hands struggle in vain to grasp the picture on the farther wall, or to reach the moon. The notion of weight dawns upon our minds as the toy falls from our loosened grasp to the floor. In these and other ways Nature herself is our teacher; and we learn rapidly enough when not to do so involves us in continual physical suffering.

In our journey through life thousands of objects impress themselves on our mere outward eyes, yet are never really observed by us. Nay, they may actually in some degree reach the inner eye, and yet from want of training, or ignorance, or carelessness, we may never see these things as they essentially are, or as they would be seen by one whose observing faculty had been duly cultivated.

Some years ago I had an amusing illustration of this familiar fact in the case of a cottager in Ayrshire who stopped me on the high-road near his own door, late one autumn evening, to show me a will-o'-the-wisp. Never having had the good fortune to encounter one of these legendary sprites, I was naturally curious to see and hear about this example. I was told that it appeared in damp breezy weather in autumn and spring, usually in the evening, and never anywhere else than over the rubbish heaps of a deserted coal-mine. The light seemed, indeed, to my rather sceptical eyes strangely like the flicker of cottage windows seen behind some waving trees; but my informant assured me that he had watched the thing for fully thirty years, and could not be mistaken. Leaving him at his cottage, I made straight across a succession of fields and fences, and soon reached, in the fading twilight, the mound at the old coal-mine. There, however, I sought in vain for will-o'-the-wisp; but about a quarter of a mile farther on, on the other side of a strip of wood, now visible, now concealed, as the leaves happened to be stirred by the wind, were the flickering lights of a row of cottages. My friend had noted the lights, had even correctly enough connected their flickering with breezy weather; but his observations had gone no further, and so for thirty years he was content with an hallucination which he could at any time have dispelled in five minutes.

Many men never get very much further in their questioning and experiment of the external world than that degree of child-like experience which enables them to keep themselves from bodily harm or to obtain the means of bodily enjoyment. If this habit of observation be not already born and active in them the usual discipline of modern education does little to engender or quicken it. They are left to learn the use of their eyes as they best may, or to pass through life without ever learning to use them at all. There is still no special training in the cultivation of the observing faculty—a training not to be taken or left at the expense of parent or scholar, but which shall be an essential and imperative part of education.

Nevertheless, though this great faculty is left to such scanty collateral influences as it may receive from the already-authorised lines of instruction, it is as certainly capable of cultivation and improvement as any other part of our mental organism—nay, upon its proper cultivation much of our welfare and of our highest pleasure depends. Surely it is not too much to demand that a faculty to which the present epoch of human history owes in especial measure its characteristics, shall be recognised as one of the parts of our nature to be sedulously cared for in the instruction of youth?

Among the reforms of the future one will assuredly be the supplying of this defect in our present system of education. And in no way can this be so advantageously done as by the practical teaching of some branch of natural science. We may not increase the army of scientific discoverers, and there is no need that we should; but we shall at all events equip each man and woman with better armour for the battle of life, adding vastly at the same time to their capacity for some of the purest pleasures which are obtainable in this world.

2. Whatever tends to stimulate the imaginative faculty, taking us out of the routine of daily life, and enabling us to realise times and conditions different from those in which we live, helps to raise us in the dignity of thinking beings. This faculty is well cultivated by some parts of the traditional system of education. Literature, notably history and poetry, afford endless materials for this purpose. These materials deal largely with questions having a more or less distinctly human interest. Nevertheless, though man is himself the proper study of mankind, his conceptions cannot fail to be enlarged when he is brought face to face with a whole world of phenomena lying outside of himself and his experience. Such enlargement it is one of the tasks of science to ensure.

You will find it sometimes gravely asserted to be "a deviation from the correct use of language and a confounding of things essentially distinct to say that a man of science stands in need of imagination as well as powers of reason." I hope that before long you will perceive the fallacy of such an assertion and recognise the necessity of imagination not in the man of science only, but in every one who would adequately master the aims and results of scientific thought. Imagination, that is, the power of shaping in our minds a distinct picture of what from many observations of facts we determine to be the plan of nature, either now or in the past, lies at the very bottom of all thorough scientific research. Without imagination to gather them all up into a luminous conception, the scattered observations of countless independent workers would lose half their meaning, and indeed would often never be made at all, for in many cases they are themselves the suggestion of imagination. To deny to Science the use of this faculty would be to clip her wings, to forbid her to soar into the highest heavens, and to condemn her to a mere ant-like industry upon this nether earth.

In adding to the present curriculum of a liberal education some training in scientific habits of mind and work, we should in no wise deaden or hamper the free use of the imaginative faculty. On the contrary, we should furnish it with the complement of that anthropomorphic or subjective method of viewing things which mere literary training is apt to produce We should enable it to take a freer, wider grasp of creation and of man's place therein.

[The speaker here illustrated his argument by an example drawn from the geology of the neighbourhood of Edinburgh.]

Now this is but an ordinary and simple example of the kind of mental processes through which geology requires us to pass. There seems little worthy of note on a group of moss-grown lichened stones on a bare hill-side; yet the observing faculty, once put on the alert, readily detects the singularity of these boulders, sets about its task of gathering all the information to be gleaned regarding them and of preparing a body of evidence to be weighed and decided upon by the judgment. And then arises the imaginative faculty with its power of reproducing the past. Under its sway woodland and cornfield seem to melt away before us, the hills are once more sealed in ice, and fleets of boulder-laden bergs come drifting over what are now the fertile plains of the Lothians.

While, therefore, in the work which lies before you here it will be your endeavour to add to your knowledge, do not lose an opportunity of cultivating at the same time these two faculties. So long as your knowledge is merely from books, so long as you are content with a kind of mere cramming, such an opportunity will be little likely to occur. It is when you turn your knowledge to account and seek for illustration or expansion of it by direct personal appeal to Nature that your powers of observation and imagination will have free play.

Fortunately we meet in a district rich in incentives to appeals of this kind. Every crag and dell around seems to beckon us to its side that it may set problems before us for solution. Part of the work of the winter will lie in availing ourselves of these opportunities. We shall make visits to the hills and quarries of the neighbourhood, and test the lessons of the lecture-room by actual seeing and handling of the rocks.

Thus, while we gain larger conceptions of the structure and history of the planet on which we dwell, we shall at the same time perform no unimportant part in that long education which, though it stands out more prominently in our earlier years, is not less surely the business of our lives.

THE RECENT STAR SHOWER

A CONSIDERABLE number of exact determinations of the place of the radiant-point of the shooting stars recorded during the recent meteoric shower have during the last few days continued to reach me, of which the accompanying general list and a rough outline map (Fig. 2) will, perhaps, best convey the general result at present arrived at regarding this important point in connection with the astronomical character of its appearance. That the stream of meteors, originating in the materials of Biela's comet, pursue, in a current of great length and thickness, nearly the same orbit as that of the comet round the sun, may be clearly concluded from the many observations of the meteor shower which have now been brought together. Among the most interesting of the descriptions relating to this subject is a report by Dr. Heis, of Münster, in Westphalia, of the observations made at that observatory between 8h. and 9h. P.M., and of others which he received from distant places, of the frequency of the meteors at that and at later periods of the night. The number seen by two observers at Munster, in fifty-three minutes, between 8h. and 9h. P.M., was 2,200 meteors, 400 of which appeared in the last interval but one of six minutes before 9 o'clock, or about forty-two per minute during the whole time. At the Göttingen Observatory 7,710 meteors were counted in three hours, giving nearly the same average of frequency during the greater portion of the shower. At Svanholmsminde, in the north of Jutland, Mr. S. Tromholdt recorded, with the assistance of two observers, 600 shooting stars in the first quarter of an hour after 9 o'clock, or about forty per minute, as observed at Munster. Allowing at the latter place thirty minutes, and in Jutland forty minutes, as their longitudes in time, east from Greenwich, the great abundance of the meteors here noted nearly coincides with the second principal maximum of the shower seen by Mr. Lowe and by Prof. Grant, at Glasgow, to have occurred at about, or shortly after, 8 o'clock. From the same time until 11h. 30m. P.M. (10h. 50m. Greenwich time), Mr. Tromholdt counted 1,660 meteors in two hours and a half, indicating a greatly decreased intensity of the shower; and, although clouds then prevented further observations, a perfectly clear sky enabled him to resume them at half-past 4 o'clock A.M. (3h. 50m. Greenwich time) on the morning of the 28th, when he found the display to have entirely ceased, only four shooting stars making their appearance during the hour between half-past 4 and half-past 5 o'clock, or about 4 o'clock, Greenwich time.

In NATURE, vol. vii. p. 86, the observations of Mr. W. Swan, at St. Andrews, show that the termination of the shower had actually arrived at an earlier hour on the morning of the 28th, since, the sky being quite clear at half-past 1 o'clock A.M., no shooting stars could then be seen. A writer on the appearance of the shower at Dublin informs me that his observations fully corroborated this result, for, on looking out at about 1 o'clock (Irish, or nearly half-past 1 o'clock Greenwich time), the number of meteors was found to have diminished to about one in two or three minutes, and during a quarter of an hour after about half-past 2 o'clock, Greenwich time, not a single shooting star appeared in sight, although there was then always sufficient clear sky to enable one observer to have an uninterrupted field of view of the constellations. Both the extent of the densest portion and the limits of the extreme boundary of the stream are excellently marked by these valuable observations. There appears without doubt to have been a period of nearly uniform maximum intensity, lasting from shortly after 6 to shortly before 8 o'clock P.M., in which one observer might, under the most favourable circumstances, count from fifty to a hundred meteors per minute, or on an average about one meteor per second. The duration of this period seems to have been about an hour and a half, its centre occurring at about, or very shortly after, 7 o'clock. For about two hours after it, the shower lessened so gradually as not to fall much below a quarter of its maximum intensity until nearly 10 o'clock, but from that time it continued to decline so rapidly that soon after midnight one observer scarcely counted so many as one meteor per minute, and by 2 o'clock A.M. it had entirely disappeared. Taking its gradual rise before 7 o'clock to have been similar to its rate of diminution afterwards, and the whole time of its visibility to have been divisible into periods of two hours each, of which the central one, of greatest intensity, occurred between 6 and 8 o'clock P.M., and three others, on either side of this, might be distinguished as copious, conspicuous, and hardly more than ordinary meteoric displays, it is easy to estimate, from the known inclination at which the earth's path crosses the axis of the stream, the thickness of the meteoric stratum which it traversed in each of these successive periods. The actual width or transverse thickness of each of these meteoric strata must have been about 50,000 miles, and that of their whole sum, consisting of seven such periods, was about 350,000 miles. The diameter of the visible nebulosity of Biela's comet, as it was observed in telescopes, was estimated at 40,000 miles, and the nearest approach of its orbit to that of the earth, in 1832, was computed to be about 17,000 miles, so that the thickness of the meteor stream which the earth passed through on Nov. 27 last, exceeds these calculated dimensions by very many times. That it was, however, not the tail, or envelope, of the comet through which the earth passed, but a stream of particles left behind the nucleus of the comet on its track, was pointed out by a Dutch observer, and writer on the astronomical features of the shower (Herr Van de Stadt), in the *Arnhemsche Courant*, referred to in NATURE, vol. vii. p. 86. He founds this on the consideration that if, as the most probable calculations by Mr. Hind of the comet's path at this return inform us, it passed its perihelion on or about Oct. 6 last, and therefore, through its node, and its nearest point of approach to the earth's orbit about Sept. 14 last, it must, at the time of the occurrence of the meteor shower, have advanced some 250,000,000 miles, or about a seventh part of the whole circumference of its orbit along its path, having already passed its perihelion, and proceeded nearly as far as the orbit of the planet Mars in its subsequent departure from the sun, and its distant approach towards the opposite part of its orbit from the earth.

Projecting all the meteor-tracks which were recorded from my point of view, at Newcastle-upon-Tyne, upon a plane perspective chart of the constellations, a very evident centre of divergence of the shower from a space round a spot in R.A. 20° N. Decl. 40°, is very clearly shown by the backward prolongations of the tracks, about 60 per cent. of which pass within 4° or 5° of this place. Many of the tracks recorded were somewhat widely erratic, coming chiefly from a more northerly area, between this place and Perseus or Cassiopeia. An extension of the radiant region in that direction or possibly its definite position there would perhaps have been recognised by more numerous observations continued to a later period of the shower; but clouds completely covering the sky after 7 o'clock, made the determi-

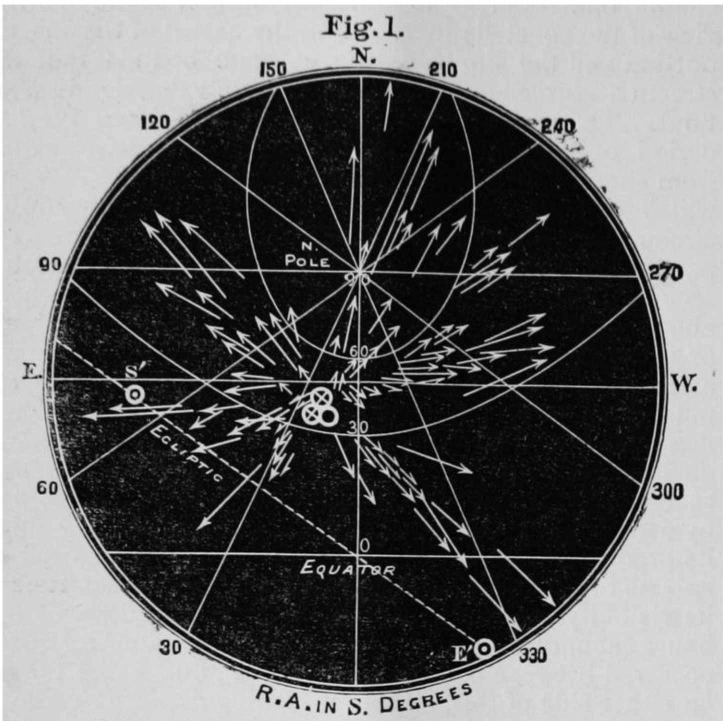

FIG. 1.—Tracks of 94 shooting stars observed at York, Birmingham, and Newcastle-on-Tyne, Nov. 27, 1872.

nation of its place by the 54 meteor-paths recorded during the preceding hour only apply to its position between 6 and 7 o'clock. The tracks of 23 meteors mapped at York by Messrs. E. Grubb, S. P Thomson, and T. H.

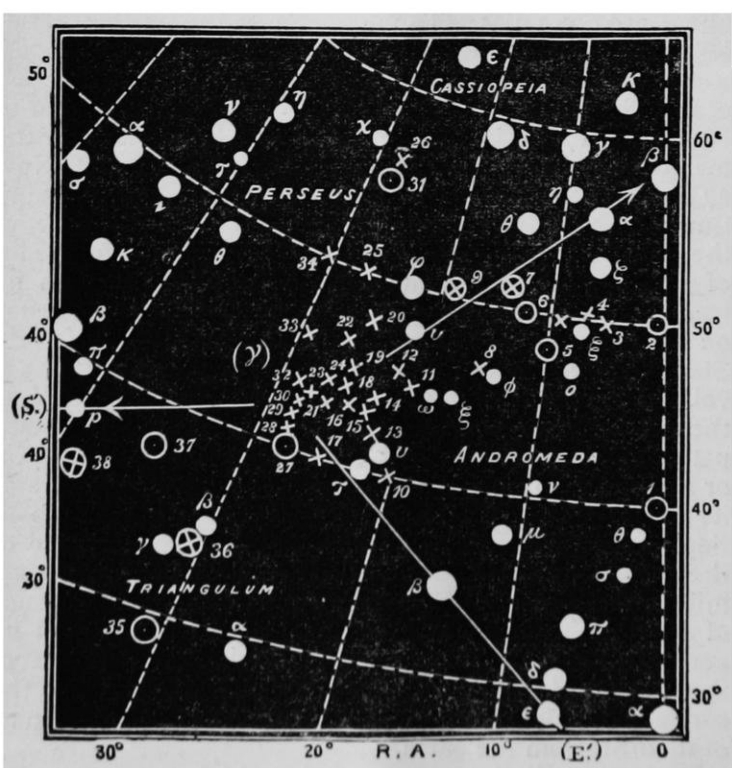

FIG. 2.—Map of the radiant points of the Meteor-shower, Nov. 27, 1872

Waller, between 6h. and 10h. 15m. P.M. were communicated to me by Mr. Waller, and those of 17 meteors noted during the same time at Birmingham, by Mr. W. H. Wood. The positions assigned to the radiant point by these observers are respectively at R.A. 25°, N. decl. 40°; and R.A. 20°, N. decl. 45°; and a circular space having a line joining these two points for its diameter, includes between 60 and 70 per cent. of the backward prolongations of the 40 meteor-paths thus

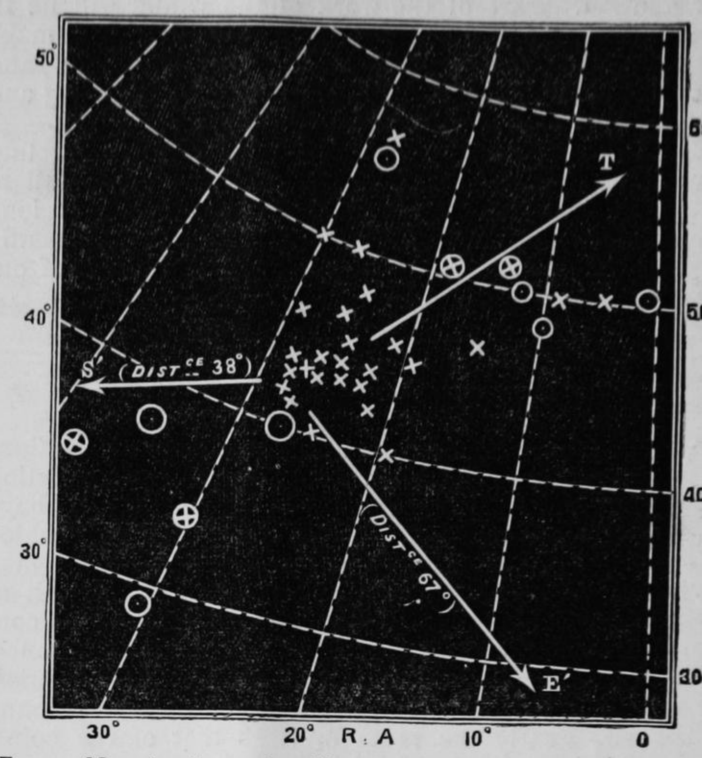

FIG. 3.—Map of radiant points, Nov. 27, 1872, and lines of direction to the points (S') opposite to the sun's place, (E') opposite to the earth's way, and (T) transverse to the last direction.

traced upon the maps. I have also received from Mr. Backhouse a list of 50 meteor-tracks observed at Sunder-

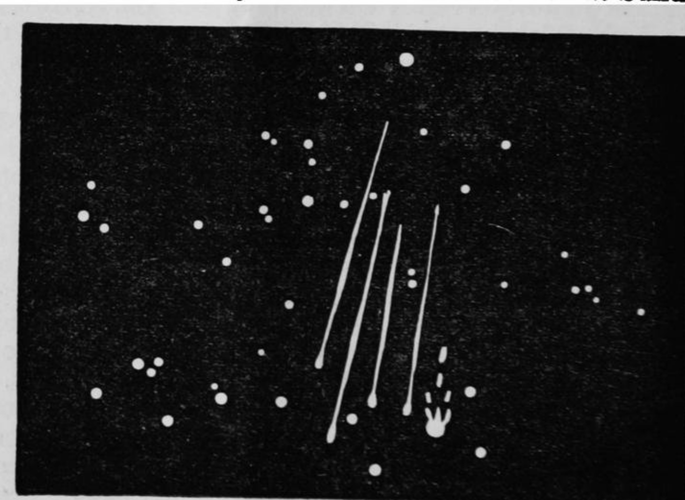

FIG. 4.—Large Meteor, at 5h 50m (the first observed), and paths of the next four meteors seen during the great meteor-shower of Nov. 27, 1872, 5h 50m 55s.—W. F. Denning (Bristol).

land before 7h. and after 9 o'clock; and a sufficient number of recorded paths from the Rev. S. J. Perry, at

FIG 5.—Flight of three collateral and contemporaneous meteors, with long parallel courses of 20° or 30°; and streak of a fourth meteor, showing its long endurance near the centre of the track. Seen during the great meteor-shower of Nov. 27, 1872.—S. H. Miller (Wisbeach).

Stonyhurst, to determine the radiant point exactly, on the night of the 27th as well as on that of December 4, when he observed some remarkable bright meteors proceeding from the same direction. It was remarked by Mr. Backhouse, and it must have been apparent to most attentive observers of the shower, that the meteors far from the radiant point did not always appear to move in parallel paths when in the same part of the sky; thus at once giving the idea that the radiant area was really of considerable extent. Although the contrary phenomenon of two or three bright meteors apparently running a race with each other in parallel courses side by side, or pursuing each other upon the same path, was frequently observed, and occasionally, as noticed by Mr. S. H. Miller at Wisbeach, who, as well as Mr. Denning at Bristol, supplied the accompanying sketch of such meteors through closely adjacent courses of 20° or 30°, yet it was perhaps in the often occurring exceptions to this rule, and in the absence of the long-enduring light streaks, left parallel to each other on such occasions by the Leonids, that the recent meteor shower differed most

APPARENT PLACES OF THE RADIANT-POINT OF THE STAR-SHOWER OF NOVEMBER 27, 1872

No.	Observer.	Place of Observation.	Local Lines of Observation. From		To		Position of the Radiant Point by the Stars and Constellations. R. A.	N.Decl	
			h.	m.	h.	m.			
1	Ph. Breton.	Grenoble (France).	7	0	8	0	(0	40°)	Between Cassiopeia and the square of Pegasus.
2	J. W. Durrad.	Leicester.					(0	50)	South-west of Cassiopeia.
3	W. H. Wood.	Birmingham.	6	0	10	15	5	50	Near ξ Cassiopeiæ (outlying radiant).
4	E. V. Pigott.	Malpas.	7	0			9	50	About ξ Cassiopeiæ.
5	Communicated by Mr. Denning.	France.					(10	48)	South of Cassiopeia.
6	Watkins Old.	Hereford.					(10	50)	A little south of Cassiopeia.
7	G. H. H.	Birkenhead.	5	30	10	0	12	50	South of μ Cassiopeiæ
8	J. J. Plummer.	Durham.	7	0			15	46·5	Close to φ Andromedæ.
9	H. Weightman.	Oundle.	5	30	7	35	18	51	Between θ Cassiopeiæ and 51 Andromedæ (υ Persei).
10	A. S. Herschel.	Newcastle-on-Tyne.	6	0	7	0	20	40	Near υ Andromedæ
11	W H. Wood.	Birmingham.	6	0	10	15	20	45	Near ω ,,
12	J. Birmingham.	Tuam (Ireland).					21·7	45·5	Near χ ,,
13	Dr. J. G. Galle.	Breslau (Germany).	6	20	7	50	22	42	Near υ ,,
14	F. B. Knobel.	Burton-on-Trent.	5	35	6	50	22·5	44	Near χ ,,
15	M. de Gasparis.	Naples (Italy).	7	0	9	0	23	43	Near υ ,,
16	A. Marth.	Gateshead.	5	45	6	30	24·5	43	Near χ ,,
17	T. H. Waller.	York.	6	0	10	15	25	40	Near γ ,,
18	T. W. Backhouse.	Sunderland.	5	30	11	5	25	44	Near χ ,,
19	R. Grant and G. Forbes.	Glasgow.	5	35	10	30	25	45	Near χ ,,
20	W. Swan.	St. Andrews (Scotland).	8	20	11	30	25	48	Near φ ,,
21	T. P. Barkas.	Newcastle-on-Tyne.	5	45	6	45	26·2	43	Near χ ,,
22	E. J. Lowe.	Beeston (Notts).	5	50	10	30	26·2	46·2	Near γ ,,*
23	S. J. Perry.	Stonyhurst.	9	29			26·6	43·8	Near γ ,,
24	Mr. Fearnley.	Christiania (Norway).	8	25	9	3	27	43	Near γ ,,
25	Dr. E. Heis.	Münster (Westphalia).	8	0	9	0	27	50	Near φ Persei (54 Andromedæ).
26	J. J. Plummer.	Durham.	9	45			27	56	Near χ Persei
27	W. B. Shorto.	Suez (Egypt).					(28	41)	General centre between Aries, Perseus, and Cassiopeia.
28	G. Lespiault.	Bordeaux (France).	5	0	9	30	28	44	Near γ Andromedæ.
29	F. Denza.	Moncalieri (Piedmont).	6	0	12	0	28	41·7	γ Andromedæ.
30	A. D. P.	Newcastle-on-Tyne.	6	0	6	30	28	41·7	Close to, if not coincident with, Mirach (γ Andromedæ).
31	H. W Hollis.	Newcastle (Staffordshire).	7	40	8	17	(28	55)	Between Perseus and Cassiopeia.
32	M. Glotin.	Bordeaux (France).	5	0	9	30	29	43	Near γ Andromedæ.
33	W. F. Denning.	Bristol.	5	50	6	30	29	46	Near γ ,,
34	M. Lernosy.	Macon (France).	7	0	13	0	30	50	Near υ, φ Persei (51, 54 Andromedæ).
35	A. Secchi.	Rome (Italy).	8	0			(31	29)	Between Aries, Triangulum, and Musca.
36	,,	,,	9	0			31	34	Near β, γ Trianguli.
37	,,	,,	12	0			(35	38)	Between Triangulum and head of Medusa.
38	W. Garnet.	Clitheroe.	7	50	8	35	40	35	A point on the verge between Triangulum and Perseus.

* The position at R.A 2h. 45m., N. Decl. 46¼°, given in Mr. Lowe's description of the shower, in the *Times* of November [illegible] is apparently a misprint for 1h. 45m. (26¼°), which is here adopted as the R.A. of the Radiant-point near γ Andromedæ, close to which star Mr. Lowe describes the appearance of a stationary meteor at 8h. 52m., as bright as that star, among the many meteors which he observed, apparently without motion about the radiant-point.

remarkably from its great precursors of the 13-14th November, 1866-7. In his suggestions to observers and conjectures on the probable early identification of this meteor-shower, published in the Transactions of the Vienna Academy of Sciences in 1868, it was remarked by Prof. Weiss, from the near approximation of the meteors in the direction of their motion to that of the earth in its passage through their stream, that the radiant region of this star-shower, even when witnessed at its greatest intensity, would probably prove to have a considerable area rather than to be concentrated, like the radiant point of the 13th of November meteors, from Leo, about a point of very accurate divergence of their tracks. From the situation of the comet's paths, and from its small velocity relatively to the earth, small deviations from parallelism in the original courses of the meteors would appear as considerably exaggerated inclinations of the visible meteor-paths to each other, and as somewhat more exaggerated ones (the original velocities of all the meteors being supposed the same)—in the proportion of about 10 to 7—when the deviation is transverse to, than when it is in the same plane as the direction of the earth's motion through the stream. In the former direction (which is 30° or 32° nearer to a meridian than the direction of the sun's apparent place) the exaggeration of the apparent meteor observations is about $2\frac{1}{2}$ times, and in the latter direction only about $1\frac{3}{4}$ times the original observations of the meteor-paths from perfect parallelism in their cometary orbits. Differences of velocity of the individual meteors from the average velocity of the stream, amounting to a tenth part of their mean speed, would on the other hand produce observations of 5° in the latter, without producing any sensible enlargement of the space included by the radiant region in the former direction. Owing to the powerful action of disturbing forces in changing both the direction and the velocities of motion of the meteors of this stream, a considerable extension of the radiant region in each direction from the mean radiant centre, might be certainly anticipated for this meteor shower. The combined causes affecting the form of the radiant area, its principal concentration along a straight or crooked line, or elongated space, and its motion with the time, are accordingly so considerable and various, that the problem of arriving at a true theory of their action must evidently be regarded as still continuing to invite further attention and research. Among the determinations of the position of the radiant point with which I have, however, become acquainted since the compilation of the present list, Prof. Newton's observations on the radiant region, which appeared in NATURE, vol. vii. p. 122, will perhaps appear, from the following considerations, to point to a somewhat more definite conclusion.

In the accompanying projection (Fig. 1) the apparent paths of the 94 meteors mapped at Newcastle-on-Tyne, York, and Birmingham are drawn on a plane-perspective chart of the heavens in their observed lengths and positions. Both their general divergence from a common centre and the irregularities of their divergence in many cases in distant parts of the sky are plainly seen, while the shortness of the paths near the radiant point clearly illustrates the effect of perspective in foreshortening the apparent courses of those meteors whose visible paths were represented, as they appeared to the observers, to be approaching them "end on." Some few of the foreshortened meteors appeared quite stationary, and two of these are represented in the drawing by a small star. Nearly round the places of these two stationary meteors are drawn small circles representing the positions of the radiant point observed at York and Birmingham; a third small circle shows the place of that observed at Newcastle-on-Tyne. They are numbered respectively 17, 11, and 10 in the list, and in the map of radiant points (Fig. 2). A small circle below the equator and another near the east point of the plain sphere upon the ecliptic (Fig. 1) represent respectively the anti-apex (or point *from which* the earth was moving), and the anti-solar point, or point *opposite to* the sun's place at the time of the star-shower. The latter point, it will be seen, is more nearly in the direction of a parallel of declination through the radiant-point than in the direction of a meridian, and it is in the direction of right ascension, or nearly in that of the sun's apparent place at the time of the shower, that a considerable elongation of the radiant region is described as having been most plainly perceived by Prof. Newton.

In the map of the radiant-places (Fig. 2), lines drawn from the star γ Andromedæ (which is replaced in the figure by the positions of several radiant-points described close to it), through β and ϵ Andromedæ, downwards, and through the small star ρ Persei towards the left, point towards the anti-apex, and to the anti-solar point; while a third line drawn from the same star nearly through υ Persei and α Cassiopeiæ is in a direction transverse to that from the anti-apex. Those radiant-points of which the star places or co-ordinates are exactly given are represented in the map by a cross; where only described by their neighbourhood to certain stars the cross is surrounded by a circle, and when simply described by the constellations their positions are represented by a circle only.

A large number of radiant-points is contained in the space included between the stars γ, τ, υ, ω, and 51 Andromedæ (υ Persei) clustering closely about a small star (not shown in the map) χ Andromedæ, near the centre of the space, of which the position is very nearly that deduced from calculation, as the probable radiant-point of the cometary shower. The direction of the outlying radiant-places is chiefly towards Cassiopeia, and shows with some distinctness a general confirmation of the conclusion obtained from direct observations of the shower by Prof. Newton, that the area of the radiant region was perceptibly elongated in right ascension, or approximately in the direction of the sun's apparent place. That the effect of the sun's attraction on a cometary cloud would be to produce an elongation of the radiant area in that direction appears on astronomical grounds to be capable of demonstration; and in their sensible agreement with this condition the results of the present observations lend satisfactory support to the astronomical theory of the meteor stream. A more complete analysis of the features presented by the radiant area would probably require a careful investigation of the disturbances which the meteor cloud may have undergone during many previous revolutions of the comet; but from the present comparison of the observations with the astronomical theory of comets and of meteor showers, there appears at least to be abundant evidence in their generally accordant results to show that beyond the regular action of universal gravitation, no powerful force of repulsion from the sun, like that supposed to be concerned in the enormous development of the tails of comets, affects the meteor orbits or changes their courses more than the regularly recurring revolutions of the planets. In the projection (Fig. 3) the radiant-points only and the directions of the three lines drawn from γ Andromedæ towards the antisolar point S′, the anti-apex of the earth's way E′, and towards a point T, at right angles to the latter direction, are represented for greater clearness without the fixed stars or constellations.

In my last letter in NATURE, vol. vii. p. 103, on the time of the maximum and the duration of the star-shower, and on meteors connected with it seen on adjacent nights, the remarkably bright meteors from the same radiant-point observed by Mr. Jackson on the evening of November 24, were noted by him near Hyde Park, and not near Regent's Park, as stated in my letter. A considerable shower of shooting stars from a radiant-point near γ Andromedæ was, it appears, distinctly observed on the same night in the United States, as described by Prof. Newton in NATURE, vol. vii. p. 122. The notes of the numbers of meteors seen after 10 o'clock, described in the last paragraph of my former letter were made by my assistants and myself at Newcastle-on-Tyne, and not at Rothbury, as would appear from their connection with the description immediately preceding them, by my correspondent on the very brilliant appearance of the shower near the latter place.

A. S. HERSCHEL

NOTES

WE believe that a reply has been received from the Government on the subject of the Arctic Expedition, which goes far to justify all that was said in our leader last week on the subject; for although the Government does not refuse absolutely to comply with the wishes of the deputation, all action will, unless strenuous efforts are made, be postponed for a year. We repeat that the deputation did not represent Science so broadly as it ought to have been represented; and we add, that if the Government thought so, it was, in our opinion, perfectly justified in refusing the demands made upon the national purse. To a certain extent, what happened in the case of the Eclipse Expedition of 1870 has been now repeated. Our readers will recollect that on that occasion the mere personal application of the Astronomer Royal was at once very properly refused, while a proper representation by the leading Societies was at once as promptly acceded to.

WE beg to draw our readers' attention to a new medical journal which commenced its career yesterday, the *Medical Record*, and which, judging from the prospectus and the contents of the first number, is likely to be of the very highest service to the important department with which it is connected, and to the sciences on which that department depends. The *Medical Record* is a weekly review of the progress of medicine, surgery, obstetrics, and the allied sciences, but does not seek to trench on the ground already occupied by other medical journals. The object of this weekly periodical will be to supply medical readers with a condensed, readable, and reliable analysis of the immense mass of information relating to the medical sciences now scattered over the surface of British and Foreign periodical medical literature. The number, the bulk, the cost, and the diffusion of the transactions and periodicals at home and abroad, in which this information is contained, are now so great as to place it beyond the reach of the most industrious. The annual transactions of the great societies of Europe and America alone occupy some scores of volumes, therefore the idea is a happy one of gathering the cream of these transactions and presenting it in an accessible and manageable form, before the transactions are out of date, to those who otherwise might never get a glimpse of them. Moreover, as the prospectus says with truth, the age of year-books has passed away, and to make the labours of scientific inquirers in the medical as well as in other departments intelligible and of practical use, they must be studied and appropriated when first announced. To enable this to be done for medicine is the object of the *Medical Record*, and we have every reason to believe it will be eminently successful in attaining its end. The new journal will be edited by Mr. Ernest Hart. The abstracts will be signed in all cases. The staff includes upwards of forty of the best known scientific members of the profession, most of them hospital teachers in London, Edinburgh, and Dublin.

SIR WILLIAM JENNER has been elected President of the Pathological Society, London.

THE Lectureship on Botany of the St. Thomas's Hospital Medical School is vacant through the resignation of the Rev. J. W. Hicks. Applications should be sent to the Medical Secretary on or before January 10.

A NEW society has been organised in Sacramento, California, under the name of "The Agassiz Institute." It has been formed on the model of the Essex Institute, Salem, Massachusetts, and owes its birth in great part to the recent visit of Prof. Agassiz in California.

A NEW work on the Cetaceans and other Marine Animals of California, is announced by Captain Scammon. It will be published by subscription through the Naturalist's Agency, Salem, Massachusetts, U.S.A.

THE planet (128) which we noted last week as having been discovered by M. A. Barrelly on the night of December 4—5, is the same as that discovered by Prof. Watson, Ann Arbor Observatory, on the night of Nov. 25, noted in NATURE of December 19 last.

THE association proposed for the promotion of explorations in Africa by the Berlin Geographical Society has constituted itself under the title of the African Society, its principal members being Drs. Schweinfurth, Rohlfs, Bastian, Peschel, Bruhns, and Petermann.

THE *Challenger* left Lisbon yesterday.

THE United States Coast Survey party, in charge of W. H. Dall, arrived in San Francisco on the 20th of September, on the *Humboldt*, after an absence of thirteen months. This time had been chiefly spent in the region between Kadiah and Oonalaska, among the Aleutian Islands. Among the more important results of the work are the determination of ten islands and rocks, fourteen harbours and anchorages (and many minor details) not on any chart; the determination of a great oceanic current, a reflected branch of the great North Pacific easterly stream, which sweeps to the south and west, south of the peninsula of Alaska and the islands, having a breadth of about 350 miles; and the discovery of new fishing banks off the southern end of Kadiah. Geological and zoological researches were carried on by the members of the party during that portion of their time when hydrographic work was impracticable; and though these investigations were entirely subsidiary to the regular work, they were crowned with unexpected success, especially in the departments of botany and geology, and the various groups of marine vertebrates. These collections, although still but superficially examined, indicate a curious resemblance in some particulars between the fauna of the region visited and that of the Straits of Magellan, a number of forms found being common to both, and not yet discovered in the intervening regions.

THE American papers talk with just pride of the great engineering feat which is now nearly completed at the expense of the Massachusetts Treasury, and which will shorten the railway distance between Boston and Troy and Albany, by 40 miles. A tunnel 4·66 miles through the Hoosac mountains has been in progress since 1855, but was not seriously entered on till 1863. The cutting was made from both ends, and so nice were the calculations of the engineers, that when on December 12th last, the two boring parties met, the two cuttings were found to vary not more than a foot either in grade or in line.

SIR BARTLE FRERE and his suite left Aden on board the *Enchantress* for Zanzibar last Saturday.

IN reference to the Cambridge Natural Science Tripos a correspondent informs us that the new scheme of examination has been carried out for the first time in this Tripos. It is as follows:—The examination occupies eight days, six in one week and two in the next, the first three of which are devoted to six papers, intended to test a general elementary knowledge of all the subjects. Two days are then occupied by practical examinations in chemistry, anatomy, and physiology; and in the last three, six papers are set, each containing several questions relating to the higher branches of each subject; and a candidate may not be placed in the first class unless he show a competent knowledge of botany, chemistry, geology, mineralogy, or physics, or of any two of the following,—Anatomy, Physiology, or Zoology; the intention being that a student should confine his high reading to one, or at most two subjects.

THE third series of meetings of the Cambridge Natural Science Club, established in March 1872, by some of the junior members of the University, was held during the last October Term; a paper was read at each meeting by the member in whose rooms the Club met, and the attendance of members and of visitors was usually good, though as the examination for the Natural Sciences Tripos approached, it fell off slightly. The following is a list of the papers, which were illustrated as far as possible with drawings, specimens, or experiments:—The Theory of Pangenesis, by Mr. F. M. Balfour (Trinity); Geological Faults, by Mr. R. D. Roberts, B.Sc. (Clare); Some Bone-caves in Herefordshire, by Mr. J. J. H. Teall (St. John's); The Rock-fragment of the Cambridge Upper Greensand, by Mr. A. J. Jukes-Browne (St. John's); The recent Deep-sea Dredging Expeditions, by Mr. P. H. Carpenter (Trinity); The derived Fossils of the

Cambridge Upper Greensand, by Mr. A. F. Buxton (Trinity); The Mechanism of Consciousness and Volition, by Mr. H. N. Martin, D.Sc. (Christ's).

MR. G. F. RODWELL lectures at the London Institution on Wednesday, 15th inst., on "Ancient Science."

THE Sunday Lecture Society has issued a very satisfactory programme for the next three months. On Jan. 26, Mr. A. H. Green gives a lecture "On the Glacial Period; a Chapter of English Geology." On Feb. 23, Mr. A. Balmanno Squire lectures on "The Skin; its Structure and Uses." Last Sunday Mr. W J Lewis lectured on "The Next Transit of Venus, and the Measurement of the Distances of the Planets from the Sun."

THE Mercers' Company have given notice that during the ensuing Hilary Term the lectures founded by Sir Thomas Gresham will be read to the public gratuitously in the theatre of Gresham College, Basinghall Street. Among them are lectures on Astronomy by the Rev. Joseph Pullen, on the 11th, 13th, and 14th inst.; Physic, by Dr. Symes Thompson, on the 17th and 18th; Geometry, by the Dean of Manchester, on the 25th and 27th.

A FUND is being raised for founding, at University College London, an Exhibition in commemoration of the services of the late W. A. Case, M.A. The Exhibition is to be held by students on leaving the college school, with which Mr. Case was connected for twenty years. The amount already promised is upwards of 300*l*.

THE Professor of Mineralogy (Mr. Miller) at Cambridge, will lecture on Mineralogy on Mondays, Tuesdays, Wednesdays Fridays, and Saturdays, from 1 to 2, in the lecture-room at the north end of the west wing of the new museum, commencing January 31.

TWO very interesting birds have just been received by the London Zoological Society, an American Stilt or Stilt-plover (*Himantopus nigricollis*), and a Darter (*Plotus anhinga*), both of them remarkable in form and appearance, and new to the Society's collection. They are to be seen in the Fish-house.

THE first number of the new monthly journal of popular antiquities, *Long Ago*, is a capital one, the contents being very varied and of wide range. If it keeps up as it has begun, it will be of real and lasting value.

A NEW series of the *Mechanics' Magazine* is to be commenced this month, under the new and admirably brief title of *Iron*.

WE would draw the attention of our readers to a series of letters on the marriage of the Emperor of China which have been appearing in the *Daily News*, especially to the one in Tuesday's issue describing the structure of "the Temple of Heaven" and other temples, in which certain astronomical notions seem to be involved, suggesting comparison with certain theories about the pyramids of Egypt.

WE are glad to see, from some scraps sent us from the New York papers, under the title of "News Splinters," that Prof. Tyndall is making excellent use of Mr. W. Spottiswoode's polariscope apparatus. So impressive and popular apparently are his lectures on polarisation, that one of the "splinters" remarks that "if anybody don't go who can get a ticket to go to hear this very remarkable course of lectures, he or she deserves rectilinear propagation into outer darkness." We believe that Prof. Tyndall is expected back on the 25th or 26th inst.

WE are glad to see, in the *Mercantile Marine Magazine*, an article on "Meteorology: Past, Present, and Future, General and Particular." It would, however, have been better had the writer had the courtesy to acknowledge that his article was suggested by, and is largely based upon, an article in NATURE for December 12 last, on the "Meteorology of the Future."

WE learn from the *British Medical Journal*, that there is some prospect that a long-talked of scheme—the removal of the Medical School of St. Andrew's University to Dundee—may be carried out. A large field for medical instruction is to be obtained in connection with the Dundee Royal Infirmary; and a similar step, that of the University of Durham, which established a Medical School in Newcastle, has not been without success.

THE following is from the *Medical Record*:—"The recent meeting at Bordeaux of the French Association for the Promotion of Science, in its first annual session, appears to have sown seed which is likely to ripen in good fruit in that city. At a preliminary meeting held on Dec. 20, a committee was named, consisting of well-known physiologists, chemists, and men of science and others, to carry out a proposed scheme of general regulations for a laboratory of physiological and chemical research. Important sums were offered for the purpose, and the muncipality of Bordeaux, appreciating the importance of encouraging scientific labours, will, it is stated, contribute handsomely to the installation and maintenance of the proposed laboratory."

THE feuilleton of the *Gazette Medicale* for January 4 contains a number of details concerning English medical education, medical fees and etiquette.

THE number of *L'Institut* for January next commences a new series. This Journal has been in existence for forty years.

STANLEY'S "How I found Livingstone," is being translated in *Le Tour du Monde*.

THERE is a very good article in the *Field* for January 4, exposing some popular delusions with regard to the dangers incurred by living in or travelling through countries where snakes are abundant. The writer thinks it would be difficult to produce a well-authenticated instance of a European having been killed by a snake in any tropical country. Many of these delusions the writer ascribes to the sensation stories found in some popular novels, *e.g.* "Tom Cringle's Log," and some of Marryatt's works, as also in the narratives of credulous travellers, and even in the works of such an eminent ornithologist as Audubon. "The actual risk incurred," the writer says, "by those who visit and explore the haunts of snakes is practically so inconsiderable as very soon to become habitually as much disregarded as is the existence of the common adder in this country." He also animadverts with justice on the extreme vagueness of the multitude of popular names applied to snakes, and speaks of the necessity of always recognising the established system of technical nomenclature, without which all is vague and delusory.

WE have received a lecture delivered before the Torquay Natural History Society by its Vice-president, the Rev. T. R. R. Stebbing, M.A., on "Museums and *Our* Museum," in which he gives some very excellent hints as to what a model museum, both general and local, ought to be. This society has been in existence for twenty-eight years, and during that time has done much useful scientific work, and accumulated a valuable collection of specimens illustrating the natural history of the country, which already exceeds the accommodation at the society's disposal. Its reference library is also rapidly increasing in bulk, and the society has therefore appealed to the Torquay public to assist in raising such a building as will satisfy the requirements of the lectures, library, and museum. Not only for the sake of the society, but for the sake of their own highest good, we hope the public of Torquay will respond liberally to the society's appeal.

THE SCIENTIFIC ORDERS OF THE "CHALLENGER"

I.

We have received from the Admiralty permission to publish the following Report of the Circumnavigation Committee of the Royal Society, on the work which lies before the *Challenger* Expedition. We are sure its perusal will gratify all our readers.

The principal object of the proposed expedition is understood to be to investigate the physical and biological conditions of the great ocean-basins; and it is recommended for that purpose to pass down the coast of Portugal and Spain, to cross the Atlantic from Madeira to the West Indian Islands, to go to Bermuda, thence to the Azores, the Cape de Verde Islands, the coast of South America, and across the South Atlantic to the Cape of Good Hope. Thence by the Marion Islands, the Crozets, and Kerguelen Land, to Australia and New Zealand, going southwards *en route*, opposite the centre of the Indian Ocean, as near as may be with convenience and safety to the southern ice-barrier. From New Zealand through the Coral Sea and Torres Straits, westward between Lombok and Bali, and thence through the Celebes and Sulu Seas to Manilla, then eastward into the Pacific, visiting New Guinea, New Britain, the Solomon Islands; and afterwards to Japan, where some considerable time might be profitably spent. From Japan the course should be directed across the Pacific to Vancouver Island, then southerly through the eastern trough of the Pacific, and homewards round Cape Horn. This route will give an opportunity of examining many of the principal ocean phenomena, including the Gulf-stream and equatorial currents; some of the biological conditions of the sea of the Antilles; the fauna of the deep water of the South Atlantic, which is as yet unknown, and the specially interesting fauna of the borders of the Antarctic Sea. Special attention should be paid to the botany and zoology of the Marion Islands, the Crozets, Kerguelen Land, and any new groups of islands which may possibly be met with in the region to the south-east of the Cape of Good Hope. Probably investigations in these latitudes may be difficult; it must be remembered, however, that the marine fauna of these regions is nearly unknown, that it must bear a most interesting relation to the fauna of high northern latitudes, that the region is inaccessible except under such circumstances as the present, and that every addition to our knowledge of it will be of value. For the same reasons the expedition should, if possible, touch at the Auckland, Campbell, and especially the Macquarie Islands. Particular attention should be paid to the zoology of the sea between New Zealand, Sydney, New Caledonia, and the Fiji and Friendly Islands, as it is probable that the Antarctic fauna may be found there at accessible depths. New Britain and New Ireland are almost unknown, and from their geographical position a special interest attaches to their zoology, botany, and ethnology. The route through this part of the Pacific will give an opportunity of checking and repeating previous observations on the structure of coral reefs and the growth of coral, and of collecting series of volcanic rocks. The Japan current will also be studied, and the current along the coast of California. The course from Japan to Vancouver Island and thence to Valparaiso will afford an opportunity of determining the physical geography and the distribution of life in these regions, of which at present nothing is known.

I.—*Physical Observations*

In crossing the great ocean basins observations should be made at stations the positions of which are carefully determined, chosen so far as possible at equal distances, the length of the intervals being of course dependent on circumstances. At each station should be noted the time of the different observations, the state of the weather, the temperature of the surface of the sea, the depth, the bottom temperature determined by the mean of two Miller-Casella thermometers, the specific gravity of the surface- and bottom-waters. The nature of the bottom should be determined by the use of a sounding-instrument constructed to bring up samples of the bottom, and also, if possible, by a haul of the dredge. When practicable, the amount and nature of the gases contained in the water, and the amount and nature of the salts and organic matter should be ascertained. As frequently as possible, especially in the path of currents, serial temperature-soundings ought to be taken either with the instrument of Mr. Siemens, or with the Miller-Casella thermometer, and in the latter case at intervals of 10, 50, or 100 fathoms, to determine the depth and volume of masses of moving water derived from different sources.

The simple determination of the depth of the ocean at tolerably regular distances throughout the entire voyage is an object of such primary importance that it should be carried out whenever possible, even when circumstances may not admit of dredging, or of anything beyond sounding. The investigation of various problems relating to the past history of the globe, its geography at different geological epochs, and the existing distribution of animals and plants, as well as the nature and causes of oceanic circulation, will be greatly aided by a more accurate knowledge of the contour of the ocean-bed.

Surface-Temperature.—The surface-temperature of the sea, as also the temperature of the air as determined by the dry- and wet-bulb thermometers, should be regularly recorded every two hours during the day and night throughout the voyage.

These records should be reduced to curves for the purpose of ready comparison; and the following points should be carefully attended to:—

1. In case of a general correspondence between the temperature of the sea and that of the air, it should be noted whether in the diurnal variation of both, the sea appears to *follow* the air, or the air the sea.

2. In case of a marked discordance, the condition or conditions of that discordance should be sought in (*a*) the direction and force of the wind, (*b*) the direction and rate of movement of the ocean surface-water, (*c*) the hygrometric state of the atmosphere. When the air is very dry, there is reason to believe that the temperature of the surface of the sea is reduced by excessive evaporation, and that it may be below that of the subsurface stratum a few fathoms deep. It will be desirable, therefore, that every opportunity should be taken of comparing the temperature at the surface with the temperature of the subsurface stratum—say at every 5 fathoms down to 20 fathoms.

Temperature-Soundings.—The determination of the temperature, not merely of the bottom of the ocean over a wide geographical range, but of its various intermediate strata, is one of the most important objects of the expedition; and should, therefore, be systematically prosecuted on a method which should secure comparable results. The following suggestions, based on the experience already obtained in the North Atlantic, are made for the sake of indicating the manner in which time and labour may be economised in making serial soundings, in case of the employment of the Miller-Casella thermometer. They will be specially applicable to the area in which the work of the expedition will commence; but the thermal conditions of other areas may prove so different, that the method may need considerable modification.

The following strata appear to be definitely distinguishable in the North Atlantic:—(*a*), a "superficial stratum," of which the temperature varies with that of the atmosphere, and with the amount of Insolation it receives. The thickness of this stratum does not seem to be generally much above 100 fathoms, and the greatest amount of heating shows itself in the uppermost 50 fathoms. (*b*) Beneath this is an "upper stratum," the temperature of which slowly diminishes as the depth increases down to several hundred fathoms; the temperature of this stratum, in high latitudes, is considerably *above* the normal of the latitude; but in the intertropical region it seems to be considerably *below* the normal. (*c*) Below this is a stratum in which the rate of diminution of temperature with increasing depth is rapid, often amounting to 10° or more in 200 fathoms. (*d*) The whole of the deeper part of the North Atlantic, below 1,000 fathoms, is believed to be occupied by water not many degrees above 32°. With regard to this "glacial stratum," it is exceedingly important that its depth and temperature should be carefully determined.

It will probably be found sufficient in the first instance to take, with each deep *bottom* sounding, *serial* soundings at every 250 fathoms, down to 1,250 fathoms; and then to fill up the intervals in as much detail as may seem desirable. Thus where the fall is very small between one 250 and the next, or between any one and the bottom, no intermediate observation will be needed; but where an abrupt difference of several degrees shows itself, it should be ascertained by intermediate observations whether this difference is sudden or gradual.

The instrument devised by Mr. Siemens for the determination of submarine temperatures is peculiarly adapted for serial measurements, as it does not require to be hauled up for each reading. It should, however, be used in conjunction with the Miller-Casella thermometer, so as to ascertain how far the two instruments are comparable; and this point having been settled, Mr. Siemens's instrument should be used in all serial soundings; and frequent readings should be taken with it, both in descending and ascending.

A question raised by the observations of the U.S. Coast Surveyors in the Florida Channel, and by those of our own surveyors in the China Sea, is the extent to which the colder and therefore heavier water may run *up hill* on the sides of declivities. The position of the Azores will probably be found very suitable for observations of this kind. Temperature-soundings should be taken at various depths, especially on their north and south slopes, and in the channels between the Islands; and the temperatures at various depths should be compared with those of corresponding depths in the open ocean.

It is in the southern oceans that the study of ocean-temperatures at different depths is expected to afford the most important results; and it should there be systematically prosecuted. The great ice-barrier should be approached as nearly as may be deemed suitable, in a meridian nearly corresponding to the centre of one of the three great southern oceans;—say to the south of Kerguelen's Land; and a line of soundings should be carried north and south as nearly as may be.

In connection with the limitation of the area and depth of the reef-building corals, it will be very important to ascertain the rate of reduction of temperature from the surface downwards in the region of their greatest activity; as it has been suggested that the limitation of living reef-builders to 20 fathoms may be a thermal one.

Wherever any anomaly of temperature presents itself, the condition of such anomaly should, if possible, be ascertained. Thus there is reason to believe that the cause of the temperature of the surface-water being below that of the sub-surface stratum, in the neighbourhood of melting ice, is that the water cooled by the ice, by admixture with the water derived from its liquefaction, is also rendered less salt, and therefore floats upon the warmer and salter water beneath. Here the determination of Specific Gravities will afford the clue. In other instances a warm *current* may be found beneath a colder stratum; and the use of the "current-drag" might show its direction and rate. In other cases, again, it may happen that a warm submarine spring is discharging itself,—as is known to occur near the island of Ascension. In such a case, it would be desirable to trace it as nearly as may be to its source, and to ascertain its composition.

Movements of the Ocean.—The determination of *Surface*-Currents will, of course, be a part of the regular routine, but it is particularly desirable that accurate observations should be made along the line of sounding in the Southern Ocean, as to the existence of what has been described as a general "Southerly set" of Oceanic water, the rate of which is probably very slow. It is also very important that endeavours should be made to test by the "current-drag," whether any *underflow* can be shown to exist from either Polar basin towards the Equatorial region. A suitable locality for such experiments in the North Atlantic would probably be the neighbourhood of the Azores, which are in the line of the glacial flow from the North Polar Channel. The guide to the depth at which the current-drag should be suspended, will be furnished by the thermometer, especially where there is any abrupt transition between one stratum and another. It would be desirable that not only the rate and direction of surface-drift, but those of the subsurface-stratum at (say) 200 fathoms' depth, should be determined at the same time with those of the deep stratum.

Tidal Observations.—No opportunity of making tidal observations should be lost. Careful observations made by aid of a properly placed tide-pole in any part of the world will be valuable. Accurate measurements of the sea-level once every hour (best every *lunar* hour, *i.e.* at intervals of $1^h\ 2^m$ of solar time) for a lunar fortnight (the time of course being kept) would be very valuable information.

Bench-marks. In reference to the interesting question of the elevation or subsidence of land, it will be very desirable, when sufficient tidal observations can be obtained to settle the mean level of the sea, that permanent bench-marks should be established, recording the date and height above such mean level. Even recording the height to which the tide rose on a certain day and time, would render a comparison possible in future years.

A good determination of the mean sea-level by the simple operation of taking means may be made, in less than two days, with even a moderate number of observations *properly distributed so as to subdivide both solar and lunar days into not less than three equal parts.* Suppose, for example, we choose 8-hour intervals, both solar and lunar. Take a lunar day at $24^h\ 48^m$ solar time, which is near enough, and is convenient for division; and choosing any convenient hour for commencement, let the height of the water be observed at the following times, reckoned from the commencement:—

h	m.	h.	m.	h	m.
0	0	8	0	16	0
8	16	16	16	24	16
16	32	24	32	32	32

The observations may be regarded as forming three groups of three each, the members of each group being separated by 8 hours solar or lunar, while one group is separated from the next by 8 hours lunar or solar. In the mean of the nine results the lunar and solar semi-diurnal and diurnal inequalities are all four eliminated.

Nine is the smallest number of observations which can form a complete series. If the solar day be divided into m and the lunar into n equal parts, where m and n must both be greater than 2, there will be mn observations in the series; and if either m or n be a multiple of 3, or of a larger number, the whole series may be divided into two or more series having no observation in common, and each complete in itself. The accuracy of the method can thus be tested, by comparing the means obtained from the separate sub-series of which the whole is made up.

Should the ship's stay not permit of the employment of the above method, a very fair determination may be made in less than a day, by taking the mean of n observations taken at intervals of the nth part of a lunar day, n being greater than 2. Thus if $n=3$, these observations require a total interval of time amounting to only $16^h\ 32^m$. The theoretical error of this method is very small, and the result thus obtained is decidedly to be preferred to the mere mean of the heights at high and low water.

The mean level thus determined is subject to meteorological influences, and it would be desirable, should there be an opportunity, to redetermine it at the same place at a different time of year. Should a regular series of observations for a fortnight be instituted, it would be superfluous to make an independent determination of the mean sea-level by either of the above methods at the same time.

Besides taking observations on the ordinary waves of the sea when at all remarkable, the scientific staff should carefully note circumstances of any waves attributable to earthquakes.

Specific Gravity.—The Specific Gravity of the surface and bottom-water should be carefully compared, whenever soundings are taken; and whenever Serial Soundings are taken, the Specific Gravity at intermediate depths should be ascertained. Every determination of specific gravity should be made with careful attention to temperature; and the requisite correction should be applied from the best Table for its reduction to the uniform standard of 60°. It would be well to check the most important results by the balance; samples being preserved for examination in harbour. Wherever the temperature of the surface is high—especially, of course, in the intertropical region—samples should be collected at every 10 fathoms for the purpose of ascertaining whether any effect is produced upon the specific gravity of the upper stratum by evaporation, and how far down this effect extends.

Transparency of the Water.—Observations for transparency should be taken at various depths and under different conditions by means of Mr. Siemens's photographic apparatus. As, however, the action of this depends upon the more refrangible rays, and the absorption of these and of the more luminous rays might be different, and that in a manner varying with circumstances, such as the presence or absence of suspended matter, &c., the transparency of the sea should also be tested by lowering a white plate or large white tile to various measured depths, and noting the change of intensity and colour as it descends, and the depth at which it ceases to be visible. The state of the sky at the time should be mentioned, and the altitude of the sun, if shining, roughly measured, or if not shining, deduced from the time of day.

Relation of Barometric Pressure to Latitude.—In Poggendorff's "Annalen," vol. xxvi. 1832, p. 395, is a remarkable paper by Prof. G. F. Schouw on the relation between the height of the barometer at the level of sea, and the latitude of the place of observation. At page 434 is a rough statement of the results of his researches, the heights being given in Paris lines.

Lat. °	Barometer mercury at 0° C.
0	337·0
10	337·5
20	338·5
30	339·0
40	338·0
50	337·0
60	335·5
65	333·0
70	334·0
75	335·5

The expedition might contribute to the examination of this law, not only by giving special attention to the barometer observations at about the critical latitudes 0°, 30°, 65°, 70°, but also by comparing any barometers with which long series of observations have been made at any port they may touch at, with the ship's standard barometer.

It appears probable from Schouw's paper, that certain meridians are meridians of high pressure and others of low pressure.

For comparison of barometer and measures of heights, it appears that the aneroid barometer constructed by Goldschmid of Zurich, would be very useful.

It is very desirable that the state of the barometer and thermometer should be read at least every two hours.

(To be continued.)

TERRESTRIAL MAGNETISM*

II.

THE problem was attacked later on by General Sabine in a much more definite manner, and with much greater chance of success. The earth, as we are all well aware, moves round the sun in an elliptic orbit, the nearest approach of the two bodies occurring at about the time of the winter solstice; if, therefore, there be an annual inequality, it will probably attain its maximum when the earth is in perihelion, and its minimum at aphelion, since the magnetic force is known to vary inversely as the square of the distance. The year was, therefore, divided by Sabine into two equal parts, and the mean of all the observations taken during the six winter months compared with the mean for the six summer months. The records of the three British observatories of Hobarton, Toronto, and Kew all agree in showing that the magnetic intensity of the earth is greater in winter than in summer. This was very satisfactory; but the same calculations have since been made for other magnetic stations, where monthly determinations of the three elements are carried on without interruption, and some of the results are far from confirming the above conclusion; for we find that observatories as near as Kew and Greenwich are in direct opposition on this point. A more extensive series of comparisons will finally show how far this disagreement depends on the accidental nature of the observing stations; but at present the preponderance of the evidence is decidedly in favour of a semi-annual inequality.

A similar investigation of the effect of the moon's action on terrestrial magnetism requires a series of observations made at much less distant intervals than the monthly ones, which suffice for the study of the annual variation. This new question presents itself to our view under a twofold aspect. The effect of the moon may be studied either in its independent action, or as it acts conjointly with the sun; in the former case we must group the observations with respect merely to the position of the moon in its orbit, and, as this is an ellipse with the earth in the focus, the force, varying inversely as the square of the distance, will have its maximum disturbing influence at perigee and its minimum at apogee. The range also of the inequality will depend on the eccentricity of the orbit, and the period of variation will coincide with the siderial, or more strictly the anomalistic, month of a little over twenty-seven days.

But if we consider the moon as acted upon by the sun, receiving its magnetic power, as it does its light and heat, from the central body of our system, or merely having its own inherent magnetism modified by solar action, then we must choose as our unit the lunation, or synodic month of 29·5 days, observing the changes that take place as the moon approaches to or recedes from the sun. A careful sifting of the Greenwich observations led Mr. Airy to a belief in the existence of a menstrual inequality of the declination, attaining its maximum on the fifth day of the moon's age, and of a semi-menstrual inequality of the horizontal force whose maximum occurs on the second day. The solar effect on the moon's magnetic power would, therefore, appear to be cumulative, and not to be fully developed till several days subsequent to the conjunction of the two bodies.

No examination seems to have been as yet made to test the existence of a monthly variation due to the independent action of the moon, as the sole disturbing force.

The sun's rotation on his axis presents another not improbable cause of periodic magnetic disturbance. For if the sun acts as a large magnet directly upon the earth, and the poles of the sun's axis of rotation are not coincident with its magnetic poles, the rotation will present the solar magnetic poles alternately to the earth, and these acting singly, the result must be a synodic inequality, dependent on the period of the sun's rotation. The absence of any such irregularity is adduced, by a recent author on terrestrial magnetism, as a proof that the variations of the earth's magnetic force are due solely to the indirect action of the sun; but Prof. Hornstein has just succeeded in detecting in the magnetic records of Prague and Vienna an inequality in very close accord with the synodic period of the rotation of the solar spots. The magnetic period of 26 days 8 hours would give, as the true time of the sun's rotation, 24d. 13h. 12m., whereas Spörer, from the most accurate observations of spots near the sun's equator, found the time to be 24d. 12h. 59m. It becomes, therefore, probable that the sun has a direct magnetic action upon the earth, but this need not in the least interfere with the probability of its simultaneous indirect action by means of its thermal energy.

Having been able to detect, in the manner just described, the inequalities arising from the orbital motions of the earth and moon, we are immediately tempted to suppose that the diurnal rotation of the earth must also exert a not inconsiderable effect on the magnetism of any particular station on the earth's surface, and possibly even affect terrestrial magnetism as a whole. It is well known that change of temperature has a very powerful influence on magnetism, and therefore we should be astonished to find that the daily range of temperature induced no corresponding range in the earth's magnetic elements. The freely-suspended magnet is the most delicate of thermometers, and consequently, unless we wish the diurnal variation of the earth's magnetism to be completely veiled by the more extensive changes due to the varying heat of the magnet itself, we must take the greatest care to keep the suspended needle in a locality not directly affected by the daily alternations of temperature. Attending to this precaution, by building our magnetic chamber at a considerable depth below the surface of the ground, we still find that there exists a most decided daily range in the motion of the magnet, to which the most delicate thermometer is wholly insensible. This daily range was detected by Graham as early as 1724, and a momentary inspection of nearly any two days' march of the suspended needle will suffice to make this point evident. The maximum west declination, about 2 P.M., is constant throughout the year, whilst the principal minimum varies with the seasons, as do also the secondary maximum and minimum. Canton has accounted for the leading feature in this diurnal change by the fact that the solar heat lessens the magnetic power of that portion of the earth on which it directly falls, and thereby gives a preponderating influence to the opposite portion, whose strength remains undiminished; the needle, therefore, moves towards the West in the morning, and only returns towards the East as the Western sun restores the balance of attracting forces.

But there are other variations of the daily range besides those just mentioned, for not only do most of the inflections of the diurnal curves alter their time with the progress of the sun in his orbit, but the amplitude of the range passes through a constant order of phases as each year advances. Dr. Lloyd discovered that the maximum range of declination in summer is greater than in winter, and Quetelet not only confirms this, but also finds that the range is greater at the equinoxes than at the solstices. It was whilst engaged upon this investigation that the Director of the Brussels Observatory made the curious discovery, that the magnetic energy varies in the same manner as the vegetable force, both attaining their maximum in April, and diminishing gradually until they reach their minimum of intensity in the

* Continued from p. 173.

winter months. Other observers, such as Lamont of Munich, Col. Beaufoy, &c., may be cited in confirmation of the existence of this apparent connection between the vegetative force and that of magnetism, a connection which may perhaps serve to throw some light on the nature of magnetic action. The horizontal force follows a law similar to that of the declination, varying in its daily range with the seasons, and attaining its maximum value in summer.

Another peculiar semi-annual inequality in the diurnal variation has been detected by Mr. Chambers, the times of opposition being the equinoxes. This inequality is found to exist in the observations taken at seven stations—five in the northern, and two in the southern hemisphere. It only lasts from 6 A.M. to 6 P.M., reaching its maximum at 9 A.M. from January to June, and at 3 P.M. from July to December, always passing through the mean value at noon.

If now we turn from the consideration of the effect of the earth's rotation on the direct solar magnetism to examine its influence on that of our satellite, we are again led to expect a positive result, but on very different grounds from those we have just been reviewing. The heat sent to us by the moon, even when full, is so insignificant, that it is requisite to collect the rays in some enormous mirror, such as that of the Earl of Rosse, or to bring them to a focus on a very sensitive thermometer, in order to make it sensible. It would be absurd then to look for any effect that the rotation might produce in the variation of the temperature; but it is very reasonable to expect that the alteration of distance due to the rotation will not be equally insensible. We are not separated from our satellite by more than 240,000 miles, and as the diameter of the earth is nearly 8,000, the rotation may alter the distance of the moon from a station on the earth's surface by about one-thirtieth of the whole distance, and the resulting change of the attracting force must be very considerable. An examination of the Greenwich magnetic observations, arranged according to lunar hours, has led Mr. Airy to the conclusion that no doubt can be entertained as to the existence of a luno semi-diurnal inequality, though he has failed to detect any luno diurnal inequality. He also found so close an agreement between the values of the luno semi-diurnal variation in the years of greater and also of smaller solar curves, that he suggests the two following "conjectural reasons for this remarkable association in the time-law of changes of solar and lunar effect. One is that the moon's magnetic action is really produced by the sun's magnetic action; and a failure in the sun's magnetic power will make itself sensible, both in its direct effect on our magnets, and in its indirect effect through the intermediation of the moon's excited magnetism. The other is, that, assuming both actions, solar and lunar, to act on our magnets indirectly by exciting magnetic powers in the earth, which alone or principally are felt by the magnets, the earth itself may have gone through different stages of magnetic excitability, increasing or diminishing its competency to receive both the solar and lunar action." The ratio of the moon's disturbing action on the horizontal force is to that of the sun as 1 to 20.

We have just been considering the irregularities in the magnetic action of the sun and moon, which arise from the orbital motions of the earth and its satellite, and from the rotation of our globe, but there are still other variations depending on much more complex causes that remain yet to be examined. A very important inequality has been detected in the daily range by several observers, and of late years by Mr. Chambers of the Colaba Observatory. It is a change that takes place in the amplitude of the range, not from season to season, but from year to year, and which completes its cycle in ten or eleven years. Other periodical inequalities of the daily range have been more than suspected, as that of twenty-two years, noticed by Hansteen; and some of these may possibly be found to have a connection with such phenomena as the revolution of the moon's nodes. It will suffice to have mentioned these; but we must not so lightly pass over the decennial period, which is identical with the cycle of those great but irregular disturbances of which we must now say a few words.

The accurate study of magnetic storms was nearly impossible before photography was called to the aid of the observer; but now that every movement of the needle is faithfully recorded by the ever watchful light of the gas jet, a continuous curve shows at a glance the nature, extent, and duration of even the slightest disturbance. The arrangement of these self-recording magnets is extremely simple and equally effective. To each magnet, whose movements we desire to study, is attached a small mirror, and the rays from a gas jet falling on the mirror are sent by it to a cylinder covered with sensitised paper. A lens brings the rays to a focus on the cylinder, and this focus traces on the paper every movement of the magnet. A second mirror fixed immediately underneath the first, but having no connection with the magnet, sends the rays of the gas jet always in the same direction, and thus traces a base line from which the variations of the magnetic curve can be measured with the greatest exactness. A clock turns the cylinder through a complete revolution in twenty-four hours, and the light being cut off for a few minutes every two hours, breaks are thus made in the curve, which serve as an excellent time scale. The magnetic curves, traced in this manner, are in general and lightly irregular lines, which reach their highest point towards 2 P.M., and are more or less curved at all hours of the day. Scarcely a day passes without some apparently accidental departure from the ordinary bend of the line, but these disturbances are often only of short duration. There are, however, occasions on which the magnets seem to be subject to the action of a disturbing force far exceeding in intensity any of those we have been hitherto considering, and subject itself to no apparent laws, but causing the needle not unfrequently to oscillate through several degrees of arc on either side of its mean position. It will be interesting to know what account can be given of this disturbing power, which assumes such Protean shapes, at one time raising a storm that dies away as gradually as it commenced, and at another bursting forth in an instant in all its fury; now continuing its disturbing action for days together, and then imparting but a single momentary impulse; affecting sometimes one element, and then another, and sometimes all together; and finally appearing not unfrequently at the same hour on several successive days.

The coincidence of these disturbances with the passing of earth currents, so perfectly recorded on the Greenwich curves; their never-failing appearance at all auroral displays; their simultaneous occurrence at places the most remote from each other; and lastly the agreement of their period of variation of intensity, as well as their maxima and minima with the decennial period, and the maxima and minima of sun-spot development; all these facts will be most powerful aids towards the solution of our difficulty. Neither is it unreasonable to expect that some light may be thrown upon the question, if we examine with careful attention the not impossible connection of magnetic storms with solar outbursts, or with volcanic eruptions and violent earthquakes, with the variations of the wind, or even with the showers of falling meteors. Much of interest has already been ascertained in connection with these several points, but I will not tax too severely your indulgent patience by entering at present into these details.

I must, however, before concluding, allude for one moment to those researches of De La Rue, Stewart, and Loewy on solar physics, in which they have made a first step towards establishing a connection between the period of solar spots and the relative position of the planets. If this can be maintained; if the solar disturbances are in any way due to the combined action and reaction of the planets, and these again are found to be coincident with the great perturbations of terrestrial magnetism, shall we not be inclined to attribute a wider range to the magnetic force than is in general assigned to it? May not that, which has long been allowed to rank among the most extensively diffused of nature's agents, find a home in each individual member of the solar system, causing them to act and react upon each other as well by their magnetic energy as by their force of gravity? The perfect solution of such a problem would well repay many a year of persevering observation and of assiduous study, and well will those be rewarded by whose labours the general cause of terrestrial magnetism ceases to be one of the unsolved mysteries of cosmical physics.

SCIENTIFIC SERIALS

No. 3 of the *Bulletin de l'Académie Impériale des Sciences de St. Petersburg*, t. xvii., contains seven anatomical papers by Dr. Wenzel Grüber—six on various abnormal muscular forms, and the seventh being an account of the formation of supernumerary wrist-bones.—An appreciative paper on Sir Roderick Murchison is communicated by G. Helmensen. He refers to Murchison's visits to Russia between 1840 and 1845 to study the palæozoic formations. In a *résumé* of results, he mentions, among others, the discovery, in post-pliocene strata in the lower course of the

Dwina, of the shells of species still extant in northern seas; of a Jurassic formation in large zones and fields between the Volga and the Timan Hills, at the western base of the Urals, and in the north-east part of the Caspian lowland; and of two quite distinct coal beds in Central Russia. The writer considers that the work of our countryman has been imperfectly followed up these twenty-five years. He speaks in warm terms of Sir Roderick's friendship for the Russians.—In a note by M. Jacobi, it is suggested to apply galvanoplastic art to the production of standards of length, on the principle that electrodes having the same dimensions and position, baths the same composition and temperature, currents the same intensity, the deposits produced in such circumstances ought to be very nearly equal. Details of such a method are fully given.—A lengthy article by Dr. Hildebrand gives an outline of some 600 historical documents among the archives of the town of Revel, which throw considerable light on the commercial relations of Russia and Livonia in the fifteenth and sixteenth centuries.—The number contains, in addition, two short notes on Faye's comet and the Fossil Cetacea of Europe.

SOCIETIES AND ACADEMIES

London

Entomological Society, Jan. 6.—Prof. Westwood, president, in the chair.—Mr. McLachlan exhibited a collection of coloured figures of the transformations of twenty-one species of Japanese *Sphingidæ*, beautifully executed by a native artist employed hy Mr. George Lewis, long resident in Japan. Prof. Westwood exhibited the net-work cocoon of a small moth from New Granada, attached to a leaf on which was also placed the body of a butterfly (one of the *Hesperidæ*), strongly affected by fungoid growths. Mr. E. Saunders exhibited two species of *Buprestidæ* from the Pelew and Caroline Islands respectively, apparently belonging to a new genus, yet resembling, in external characters, two species of *Chryovdema* from the E. India Islands.—Mr. Champion exhibited two species of *Coleoptera* new to Britain.—Mr. Miller called attention to a recently printed Government report respecting the ravages of the vine-scourge (*Phylloxera vastatrix*). An interesting discussion took place, in the course of which Prof. Westwood stated that, to the best of his belief, the first notice of its occurrence in Europe was made by himself in a paper read before the Ashmolean Society of Oxford regarding its ravages in this country.—Dr. Sharp communicated a paper on the water-beetles of Japan, in which he mentioned that, although there were many European species occurring in the Japanese Islands, yet there was also a cons derable admixture of Asiatic forms.—Mr. Wollaston followed by a paper on the *Cossonidæ* of the same islands. He stated that the ordinary European types of that family do not prevail in Japan, but are replaced by kindred or representative forms. Mr. Pascoe thought that the fauna of Japan, like that of Madagascar or New Zealand, might be termed a satellite fauna, which, while having many endemic forms, had yet a great deal in common with the neighbouring continent. Mr. Bates asked that judgment upon the question be suspended; although many Western European species were also found in Japan, the collective faunas of the two regions were totally different, and if they found only one fauna in common, the majority of the genera ought to be the same, which was apparently not the case.

Philadelphia

Academy of Natural Sciences, June 11, 1872.—Professor Cope offered some remarks on the discoveries recently made by Professor Marsh as to the structure and characters of the *Pythonomorpha*, based especially on material recently obtained by him in Kansas. As the writer had recently passed in review much similar material, he was much interested in Prof. Marsh's conclusions. These, he said, were of importance. In the first place, he had ascertained that what was formerly supposed to be the inner side of the quadrate bone was the outer side, a conclusion Prof. Cope thought entirely consistent with the other known relations of the parts. Secondly, he had discovered the stapes, and had entirely confirmed the opinion of the speaker, which Prof. Marsh had apparently overlooked. This was stated as follows:* the quadrate "is characterised by the presence of an oval pit. Its use is uncertain, but there is some probability that it received the extremity of an osseous or cartilaginous styloid stapes. A groove on the under side of the suspensorium would accommodate such a rod, and in a position nearly similar to that which it occupies in many of the Ophidia." It is in precisely this position that Prof. Marsh is so fortunate as to have discovered it. Thirdly, Prof. Marsh believes that he has found the columella. I have supposed it to be wanting, from the absence of its usual points of attachment on the parietal and pterygoid bones. It remains to compare the bone found by Prof. Marsh with ali-and orbito-sphenoid and ethmoid ossifications found in many saurians. Fourthly, Prof. Marsh has observed the parieto-quadrate arch described by the speaker, and makes the interesting observation that it is formed of three elements, the median connecting the parietal with the opisthotic. This piece, he says, is "apparently the squamosal;" as the latter bone completes the zygomatic arch, it cannot occupy a position in the parieto-squamosal, unless it sends a branch in that direction. Fifthly, he discovers the malar arch, proving it to be incomplete and supported by the postfrontal bone. Prof. Marsh also observes an ossification in the glenoid cavity of the opisthotic, which he regards as the pterotic (of "Huxley," which should be Parker), an identification which cannot probably be maintained. The connections of the pterotic, where present, are very different. The bone in question is present in *Edestosaurus tortor* Cope. Sixthly, Prof. Marsh completes almost entirely our knowledge of the anterior limbs. The previous descriptions of these members in *Clidastes propython* Cope, *Holcodus ictericus* Cope, and other species, had left the number of phalanges and their relative positions, as well as those of the carpals, uncertain; these points are now happily supplied by Prof. Marsh's important researches. Seventhly, he has done much for the pelvic arch and hind limbs. He was the first to announce the existence of both, and actually described the pelvis of *Edestosaurus dispar*; the speaker, however, first described the hind limb in *Liodon crassartus* and *L. dyspelor* Cope. Prof. Marsh is in error when he says the "absence of these extremities in the *Pythonomorpha* was considered satisfactorily established." I had never stated that they were certainly absent, and the last time I wrote observed that this order "possessed an anterior pair only, or with the posterior pair so reduced as to have been insignificant."* They appear, according to Marsh, to have been relatively small in some of the genera. In *Liodon dyspelor* Cope, the anterior are the smaller. Prof. Marsh lays students under especial obligation for his determinations of the pelvic elements and the excellent figures of all the parts connected with the support of the hind limb. His figure of the fore limb is also highly important, as it will be difficult soon to duplicate his beautifully complete specimen. In subsequent pages there are six additional species described, bringing up the number from the Kansas Cretaceous to twenty-three. Two new genera are proposed, viz., *Lestosaurus* for those previously referred by myself to *Holcodus* Gibbes, and *Rhinosaurus* for species allied or belonging to *Liodon*. As to the former, it is no doubt a well-marked genus, and I am willing to believe Prof. Marsh's opinion, that it will not include Gibbes' *Holcodus acutidens*, will turn out to be well-founded; but there is, on the other hand, insufficient evidence to show that it is not *Platecarpus* Cope. If *Liodon curvirostris* be referred to it, it will very probably prove to be *Platecarpus*, as that species presents palatine teeth, much as in *P. tympaniticus*, and the pleurodont character is not wanting in some of the other species. *Rhinosaurus* includes such species as *Liodon proriger* Cope. As the name has been used two or three times before, it may be altered to *Rhamphosaurus*, but I have always had doubts that the conic projecting snout would distinguish the species generically from the true *Liodon*, with which it agrees in dentition. The type of *Liodon*, *L. anceps* ord., is, however, very little known.

* Trans. Amer. Philos. Soc. 1869, p. 180.

* Hayden, Geol. Survey of Wyoming, etc., 1870 p. 385.

Paris

Academy of Sciences, Dec. 23, 1872.—M. Faye, president, in the chair. M. Mathieu presented the *Connaissance des Temps* for 1874 from the Bureau des Longitudes; Lieutenant Fleuriais determinations of the meridians of Shang-hai and Pondicherry are adopted in this number. The president then read a pap r on he true position of the Bureau des Longitudes. It has been proposed in the National Assembly to suppress the Bureau in order to save its cost to the nation, the president's paper was an eloquent defence of and appeal for the threatened institution.—M. Becquerel read a paper on the use of electro-chemical and electro-capillary force for the formation of amalgams and crystalline bodies of definite composition.—M. Phillips read a paper on the flow of liquids from reservoirs, maintained at a constant level, through a large orifice in a thin side.—A report on M. Arn. Thenard's researches on the effect of electric discharges on gases and vapours was next read. The author worked with a modification of Houzeau's ozonising tube; he found that a gentle discharge acting on a slow stream of carbonic anhydride decomposed 26·5 per cent. into carbonic oxide and oxygen. De Saussure, working with sparks, never succeeded in decomposing more than 7·5 per cent. A long-continued discharge acts on the glass tube and covers it with powder, and when in this state the decomposition resembles that produced by sparks, the removal of the deposit restores the original power.—M. Janssen read the first part of a report on the eclipse of December 12, 1871.—An essay on the interdependence of meteorological phenomena by Father Solaro was sent to the Physical section. —A letter from M. Denis on certain deductions tending to simplify the principles of natural philosophy was referred to a special commission.—M. Rouget's note on a theorem which extends to imaginary roots the method given by Sturm for real roots, was referred to M. O. Bonnet.—M. Yvon Villarceau presented an account of the discovery and observations of Planetoid 128 at Ann Arbor by Mr. James Watson, and also some observations of 128 made at Marseilles, by M. Borrelly.—M. F Perrier read a note on the Astronomica station of Dar-Baida near Oran.—M. Laussedat read some observations on the prolongation of the French Meridian into Spain and Algeria.—Colonel H. Levret followed with some observations on M. Laussedat's paper, and a letter to Colonel Levret on the same subject from General Blondel followed.—Next came a note on celestial mechanics by M. Newcombe.—M. de Pambour read a note on the calculus of effects by the method of coefficients applied to water wheels.—M. Wurtz presented a note by M. Gariel on the distribution of magnetism in magnets, which was followed by a new note on the action of conductors placed symmetrically about an electroscope by M. Ch. V. Zenger.—M. Balard presented a note on a new application of silver salts for the production of designs, by M. Renault. The author describes a new method of printing from engravings, &c.—A note from M. Schutzenberger on the action of Iodine on certain of the Aromatic Hydrocarbons was then read. A certain quantity of hydriodic acid is formed and acts as a hydrogenating agent.—M. Cahours presented a note by M. Jungfleisch on the Reciprocal Transformation of Inactive Tartaric and Racemic Acids and on the preparation of the former. Inactive tartaric acid is prepared by heating dextrotartaric acid and water to 160° for two days, removing the racemic acid (only a small quantity is formed) by crystallisation, saturating half the liquid with potassic hydrate, adding the other half and separating the very soluble potassium salt by repeated crystallisations.—A note by M. Defresne on the Biliary and Pancreatic Secretions of Omnivorous Animals followed. Next came a paper on Normal Torsion of the Humerus in the Vertebrata, by M. J. Durand.—M. Milne Edwards presented a note on the Structure of the Beak of the *Platalea*, by M. Jobert; and also a note on certain passages from an Arab author of the tenth century, relative to the gigantic birds of South-East Africa, by M. Devic.—A note on the Meteors of November 27, observed at Palermo, by Father Tacchini, was read.

DIARY

THURSDAY, JANUARY 9.

ROYAL SOCIETY, at 8.30.—Further Researches on the Sense of Sight in Birds: Dr. R J. Lee.—Confirmation of the Existence of an Intra-Mercurial Planet by means of the Behaviour of Sun-spots: W. De La Rue, B. Stewart, and B. Loewy.—On the Union of Ammonia-Nitrate with Ammonia: Dr. E. Divers.—On a New Method of Viewing the Chromosphere: J. N. Lockyer and G. M. Seabroke

SOCIETY OF ANTIQUARIES, at 8.30.—Further Particulars Respecting the Early Discovery of Australia: R. H. Major.

ROYAL SOCIETY CLUB, at 6

MATHEMATICAL SOCIETY, at 8.—On Parallel Surfaces: S. Roberts.—Summation of certain Series: Prof. Wolstenholme.

ROYAL INSTITUTION, at 3.—Juvenile Lectures—On Air and Gas: Prof. Odling.

FRIDAY, JANUARY 10.

QUEKETT CLUB, at 8.

ASTRONOMICAL SOCIETY, at 8.

SATURDAY, JANUARY 11.

ROYAL BOTANIC SOCIETY, at 3 45.

SUNDAY, JANUARY 12.

SUNDAY LECTURE SOCIETY, at 4.—The Musalmans of India and Central Asia: Dr. F. J. Mouat.

MONDAY, JANUARY 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

MEDICAL SOCIETY, at 8.

LONDON INSTITUTION, at 4 —(Holiday Course, II).—On Air, Earth, Fire, and Water: Prof. Armstrong.

TUESDAY, JANUARY 14.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.

PHOTOGRAPHIC SOCIETY, at 8.—On the Photographic Operations of the Royal Observatory at Greenwich with Astronomical and Meteorological Records: J. Glaisher.—The Fading of Albumenised Pictures: E. J. Gayer.

SOCIETY OF CIVIL ENGINEERS, at 8.

ROYAL INSTITUTION, at 8.—On the Forces and Motions of the Body: Prof. Rutherford.

WEDNESDAY, JANUARY 15.

LONDON INSTITUTION, at 7.—Ancient Science: G. F. Rodwell.

METEOROLOGICAL SOCIETY, at 7.—On Solar Radiation: Rev F. W. Stow. —On Temperature in Sun and Shade; an Account of Experiments made at Harpenden, Herts: Rev. F. W. Stow.—Remarks on the Pocky Cloud, observed July 27, 1872: J. S. Harding.—Account of Hurricane in Western Australia: R J. Sholl.

SOCIETY OF ARTS, at 8.—On the Sulphur Deposits of Krisuvik, Iceland; Charles W. Vincent.

THURSDAY, JANUARY 16.

ROYAL INSTITUTION at 8.—On Oxidation: Dr. Debus.

ZOOLOGICAL SOCIETY, at 4.

ROYAL SOCIETY, at 8.30.

SOCIETY OF ANTIQUARIES, at 8.30.

LINNEAN SOCIETY, at 8.—On the Recent Synonyms of Brazilian Ferns: J. G. Baker.

CHEMICAL SOCIETY, at 8.—On Ethylamyl: Mr. Grimshaw.—On the Heptanes from Petroleum: C. Schorlemmer.—On the Vanadates of Thallium: T. Carnelley.—On the Formation of Sulphide of Sodium by the Action of Sulphuretted Hydrogen upon Sodium Chloride: C. T. Kingzeth.

NUMISMATIC SOCIETY, at 7.

ROYAL SOCIETY CLUB, at 6.

BOOKS RECEIVED

ENGLISH.—The Gospel of the World's Divine Order: D. Campbell (Trübner).

PAMPHLETS RECEIVED

ENGLISH.—Natural History Transactions of Northumberland and Durham, Part 2, Vol. iv. (Williams & Norgate).—Workman's Magazine, No. 1: (Kent).—Transactions of the Institute of Engineers and Shipbuilders in Scotland.—Popular Science Monthly, No. 9.—Little Hodge: Author of "Ginx's Baby" (King).—Astronomical Register, No. 121.—Journal of Botany, No. 121.—Society of Telegraph Engineers; Annual Report.—Evidence for the Ice Sheet in North Lancashire and adjacent parts of Yorkshire and Westmoreland: R. H. Tiddeman.—Note on an Experiment to predict the Annual Rainfall: W. Pengelly.—Rainfall on the St. Mary Church Road, Torquay, during the Eight Years ending Dec. 31, 1871: W. Pengelly.—Literature of the Oreston Caverns near Plymouth: W. Pengelly.—Is it a Fact? W. Pengelly.—Signs of Hotels, Taverns, Inns, &c., in Devonshire: W. Pengelly.—On the Kombé Arrow Poison (*Strophanthus Hispidus*, D.C.) of Africa: Thos R. Fraser, M.D.—Messenger of Mathematics, No. 20.

AMERICAN.—American Naturalist, vol. vi. No. 12.—American Journal of Insanity, vol. xxix. No. 2.—Penn Monthly, Nos. 29—33.

FOREIGN.—Journal de Physique, No. 12.—Nuovo Giornale Botanico, vol. iv. No. 4.—Bulletin de l'Academie Royale des Sciences de Belgiquer No. 11.—Bulletins de la Societé d'Anthropologie de Paris, Nos. 1-4.—V. der K. K. Geologischer Reichsanstalt, No. 16.—Poggendorff's Annalen der Physik und Chimie, Nos. 12 and 13.

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