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THURSDAY, APRIL 25, 1872

A PHYSICAL OBSERVATORY

AT the last meeting of the Astronomical Society, a paper was read by Lieut.-Colonel Strange on "The Insufficiency of existing National Observatories." The title is perhaps suggestive of an attack on Greenwich, but this idea the paper at once dispels, the Royal Observatory, and the administration of its eminent director, being spoken of throughout in terms of the strongest approval, in which all astronomers must join.

The aim of the writer was to show that, though Greenwich provides most efficiently and amply for the elder Astronomy, it is now time for us to consider whether her younger sister should not also be permanently provided for. When Greenwich was founded the Physics of Astronomy, which now attract so much attention, had no existence. This department of science is entirely of modern growth; but it has already attained such wide proportions and so deep a significance that it cannot any longer with propriety be left to the chance cultivation of individual zeal. In putting forward these ideas, Colonel Strange has only given expression to what has been for some time in the thoughts of every one interested in astronomy and its correlated sciences. He is right in pointing out to the Astronomical Society that in this direction its influence can and ought now to be exerted. And he gives two very cogent reasons why this should be done at once. First, that the system of photoheliography, which has for some years been carried on at Kew by the zeal of individuals, and partly maintained by private means, has now been brought to a close. Second, that the Royal Commission on Science being now at work on the question of the advancement of science, the present opportunity is very favourable for bringing this matter forcibly before Government through that body—an opportunity which will probably not recur in a generation.

The discussion on the paper, as might be expected, was prolonged and animated. The Astronomer Royal, who spoke several times, was doubtful whether the object for which such an observatory was sought to be founded was sufficiently "secular" to ensure success; but on its being urged with great force and truth by Mr. De La Rue and Captain Toynbee—both connected officially with the Meteorological Office—that the study of the sun, as had been insisted on by Colonel Strange in his paper, must greatly aid meteorological research, Mr. Airy candidly admitted that if that pretension can be made good, there will exist a claim on behalf of Meteorology for the establishment of a Physical Observatory, similar to, and as "secular" as, that on behalf of Navigation on which Greenwich was founded.

It is certainly a little disheartening to find a great leader in science insisting so much on direct utilitarianism as the sole basis of national science, and withholding his testimony to the enormous moral and intellectual benefits of philosophical research, and even omitting all consideration of the indirect material results which have invariably followed vigorous and systematic study of natural phenomena of whatever kind. The average Englishman is prone enough to hug what in his untaught stupidity he calls "practical ideas," and will not be improved by being told by one of the first of living philosophers that such ideas are the standard by which he should measure every proposal for advancement. But it is impossible to suppose that these are the ideas which the Astronomer Royal will on mature reflection apply to the question before us, when deliberately presented to him with a view to action.

It is to be hoped, indeed, that the late discussion will be followed by action. Our Royal Astronomical Society should be the acknowledged head of modern astronomical activity. It has higher functions to perform than those on which its energies have been rather too exclusively exercised—the reading, discussing, and publishing of detached dissertations. It should from time to time take stock of the territory it occupies, in order to see what encroachments need fencing off and what expansions are required. And, above all, it should constitute itself more than it does the guide and encouraging counsellor of the Government in matters which it must understand better than they. We hope to see it awake to its moral obligations in regard to the most important matter which has been so opportunely submitted to it. We do not hesitate to say that if by its interposition a well-equipped Observatory for Physical purposes should be established, this will be the greatest service it will have ever conferred on Astronomy, and not on Astronomy only, but on a vast sphere of scientific inquiry, not obviously, but still indisputably, connected therewith.

In Meteorology such an observatory would ultimately, if not immediately, create a revolution. Instead of the dreary columns of thermometer readings piled upon us by well-meaning but aimless industry, we shall see men of thought labouring to refer to the great source of all energy, the great maintainer of all harmony, the great exciter of all variation—to the sun itself—those phenomena, at present the most difficult in the universe to interpret, which hitherto it has been assumed that any one with 5*l.* to spend on "a complete set of meteorological instruments" can help to elucidate.

Should the want now spoken of be made apparent to those who can supply it, there will be several important preliminary questions to deal with, such as (1) What should be the scope of such an observatory? (2) Should it be engrafted on Greenwich, or be independent? (3) Should Meteorology and Magnetism be engrafted on it and severed from existing connections? (4) Should a system of sun observations—the primary, though, of course, not the sole object of such an observatory—be extended to India and other British possessions, so as to ensure that continuity of facts on which Messrs. De La Rue, Balfour Stewart, and Loewy have laid so much stress in their striking memoirs on Solar Physics recently communicated to the Royal Society?

LANKESTER'S PHYSIOLOGY

Practical Physiology; being a School Manual of Health, &c. By Edwin Lankester, M.D., LL.D., F.R.S. Fifth Edition. Pp. 152. (London: Hardwicke, 1872.)

THE new title adopted by Dr. Lankester for this little work is somewhat misleading. It has nothing to do with Practical or Experimental Physiology, the sub-

ject on which interest has lately so much revived in this country, and on which we hope before long to see a treatise by competent hands. Nor would it be fair to compare this "School Manual" with the admirable "Lessons in Elementary Physiology" of Prof. Huxley. The latter, though intended for boys' and girls' schools, is only of use in the few instances in which dissection and microscopic anatomy are taught; and its chief value is for University men who do not specially take up Biology, and as the best introduction to the subject for medical students. But Dr. Lankester addresses the wider circle of the general public. He shows in the Introduction how an elementary knowledge of the functions of the body and of the rules of health may be taught in primary schools; and proceeds to demonstrate the advantage of this knowledge to statesmen, clergymen, lawyers, architects, newspaper writers, common councilmen, and artisans. Perhaps the most important part of this introduction is that in which the author urges the importance of some knowledge of what is necessary to health for women in all stations of life. A skilful teacher would be able to teach girls of average intelligence a large part, and that the most valuable, of the contents of this Manual. They would probably learn it more readily than boys, and when all memory of the tissues and their names had passed away, it may be hoped that the dogmatic injunctions and prohibitions on food and air and drains and clothing would, at least in part, survive.

The first chapter contains a fair sketch of the constituents of the human body; the second deals with food, and gives sensible advice on many points; but here there are marks of imperfect adaptation of Liebig's theories to more recent facts. The third chapter, on Digestion, is also clear and practical. The next on the Circulation is too technical for the purpose of the book, and might, we think, be relieved of many anatomical terms. The two which follow on Respiration and the Skin, are chiefly sanitary, and might be read with advantage even by those ignorant of physiology. In the seventh chapter, on Movement, Dr. Lankester gives a very uncertain sound on the subject of boat-racing (pp. 76 and 77), in the former passage going so far as to assert that "in all gymnastic exercises competition in feats of strength should be avoided." The public have been already frightened as much as they are likely to be by certain letters on the dangers of boat-racing, which appear at intervals in the *Times* newspaper. It may be said of this, as of other athletic sports, that when competition is avoided gymnastics will cease to be practised. It is surely better to attempt wisely to regulate these contests than to condemn what are just as valuable or as injurious as competitive examinations in mental athletics.

The last two chapters of this manual, which deal with the difficult subjects of the nervous system and the senses, are pleasantly written, and give much useful information; but there are more errors here than in the rest of the book. Thus the decussation of nerve fibres is made to take place in the *corpus callosum*, the arachnoid is described as a "spongy membrane," and the pathology and causes of apoplexy given on the same page are not correct. Again, the physical cause of short sight is not the cornea being too rounded, but the whole eyeball being too long, and if the reader "looks into a living human eye, through the pupil," as directed in p. 104, he will be disappointed of the promised result. In these as in other particulars the work would have been better if the writer had taken more pains. Beside a number of curious misprints, there are several minor inaccuracies scattered through the book, which a competent physiologist would correct in looking through it. Only two lines of poetry from Shakspeare and Milton occur, and both are misquoted. Similar inaccuracies are to be found in the classification of the animal kingdom printed at the end of the volume, with which it appears to have no very close connection. The glossary, on the other hand, and the questions for examination, will probably be found of practical use. The tables of the ultimate and proximate constituents of the body, also given in the Appendix, are too exact to be correct, and the same may be said of that showing the daily supply and waste. Moreover, 12lb. of fat would make but a meagre man; and 31oz. of water is more than there is reason to suppose that the lungs excrete. The woodcuts which have been added to the present edition are taken from well-known, chiefly French, sources; they are roughly reproduced, but answer their purpose well enough.

In a future edition, which we hope will be called for, it would be well to restore the original title of the work, and correct some of the inaccuracies we have referred to. It might also be desirable to give fuller directions on the choice and preparation of food, and especially of the food suitable for infants and invalids. A chapter on the general management of a sick-room as to warming, ventilation (now often carried to injurious excess), feeding, disinfection, &c., would also be a valuable addition. A short and admirable pamphlet, issued a short time ago by Dr. Bridges ("A Catechism of Health, adapted for Primary Schools," 1870), contains just those points of sanitary knowledge which are most important, and Dr. Lankester's experience as a coroner would be of great service (as it has already been) in enabling him to enlarge upon these most pressing topics, and to illustrate them by well-chosen examples.

P. S.

OUR BOOK SHELF

Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt, xxi. Band. Nro. 4; October, November, December. (Vienna, 1871.)

DR. NEUMAYR occupies the greater portion of this number of the "Jahrbuch" with the third part of his elaborate "Jurastudien." In this paper he describes what he calls "der penninische Klippenzug," a name derived from Penninberge, near Szczawnica, on the borders of Western Galicia and Hungary. The structure of this region is treated of at considerable extent. A long list of some two hundred and fifty papers, notices, &c., accompanies the memoir. Herr Franz Toula gives some account of the Randgebirges, near Karlsburg and Rodaun; and the work done in the Chemical Laboratory of the Institute is described by Karl Ritter v. Hauer. The mineralogical communications which accompany the "Jahrbuch" contain, amongst other papers, one by C. W. C. Fuchs, on the mechanical and chemical changes which lava undergoes in passing from the fluid to the solid state; and another by G. Tschermak on the problems of mineralogical chemistry. We have also descriptions of various minerals by Prof. Zirkel, Victor v. Lang, and Richard v. Drasche, and a number of miscellaneous "notices."

The Higher Ministry of Nature: viewed in the Light of Modern Science, and as an Aid to Advanced Christian Philosophy. By John R. Leifchild. (London: Hodder and Stoughton, 1872.)

MR. LEIFCHILD is already known as a careful writer on matters connected with economic geology; he now appears before the public in the avowed character of ambassador between the opposing forces of Theology and Science. This bulky volume of upwards of 500 pages appears to be a kind of commonplace-book of thoughts which have occurred to him in solitary wanderings; the title means to express that the author concerns himself with subjects higher than those which "subserve our present individual and collective interests." We must acknowledge that works of this kind, endeavouring to reconcile in detail the conflicting theories of theologians and men of science, are little to our taste; we suppose, however, they have their public; and in the case of the volume before us, the large type, wide margins, and handsome binding, are all in its favour. With this preliminary objection, that portion of Mr. Leifchild's work which comes within our scope—for the greater part does not—seems treated with considerable care and knowledge, and with a higher degree of impartiality than is usually to be met with in such works. The Darwinian doctrines of evolution and natural selection of course come in for some severe criticism; we are surprised that Mr. Leifchild should reiterate the superficial and often refuted objection that geology has not yet revealed a single fossil *in transitu* from one species to another, as if it were possible that geology should reveal anything but the successive connecting and connected links, which it has done, and is doing every day. Those who delight in speculations on the border-land between the natural and the supernatural will find much to interest them in the volume, and to such we commend it.

LETTERS TO THE EDITOR

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

Spectroscopic Nomenclature

YOUR columns were not long since opened to a discussion, rather long drawn out, on a point of nomenclature. They are now, as ever, open to all reasonable discussion on that most interesting aspect of Nature presented by the spectroscope. I cannot help thinking that some advance might be made if the faculties exhibited in the one were now brought to bear on the other. There seems to be a lamentable tendency in zealous but disorderly minds to pay as little attention as possible to those aids to reasoning—those signs of ideas, which ought to be current coin.

I do not in the least propose to myself to attempt to mount the breach just now. But I would fain challenge attention, and urge a fair amount of consideration, on some few points in which I have noticed very diverse methods of expressing the same thing. And in so doing I may find it necessary to give my voice in favour of one or the other. But it is not my object to advocate so much as to indicate.

Observations have recently been made of the sun during eclipse of a kind which, if not so novel as some think, is intensely interesting, and must be constantly referred to. I mean with a free prism. Now it occurs to me that it would be easy to reserve the spectroscope for that instrument which we have been accustomed to call such and to characterise these other observations as *prismatic*, as distinct from *spectroscopic*. It would then be known at the very outset that there was no slit. This would not prevent a juvenile disciple of Newton from repeating his prismatic examination of a chink, and getting his linear spectrum; it would only keep before him the origin and constitution of that spectrum in a way which the sole use of the spectroscope appears not to do. The prismatic and the spectroscopic methods of examining a luminous object are totally distinct. Thus the Poodocottah observations were of one kind, those at Dodabetta of the other; those at Bekul, of both. It is of no consequence, for this matter, where the prism is, it is the absence of the slit that makes the difference. Thus, for the purpose of illustration, I may allude to the planetary nebula seen *prismatically* unaffected in the midst of a star cluster turned into streaks. And the prominences seen in an open slit are to all intents seen prismatically. It is obvious that there is here a distinction of idea which may be advantageously fixed by a distinctive use of words. Let the spectroscope mind its own business, which is to make and examine linear spectra. The moment it ceases to do so it ceases to be a spectroscope.

This brings me to the next point. Since the prism does not require a slit,—on the contrary, is a very valuable tool, as we have seen, without,—it ought never to see *lines*, except as it sees other forms, *i.e.*, out lines. There is a confusion of ideas—rather, I should say, a contraction of ideas—in setting a prism to look for lines. It is the spectroscope which sees lines, the prism sees images, forms. It is an accident of the case if the form happens in any of its parts to be at the same time linear, and having its linear portion in a certain direction. Thus, when in a prismatic examination of the solar crescent immediately before eclipse, the cusps become linear—albeit curvilinear—there is a failure of grasp in speaking of the dark cusp-images as dark lines; or, at any rate, there is an opportunity lost of exemplifying the principle which pervades the whole of the phenomenon, and of fixing the prismatic idea.

The same kind of misuse of terms I have had occasion to point out on the occasion of the first prismatic examination of an eclipse, when what are now called, happily, zones, were unhappily and mistakenly called by the technical term "bands."

I now pass on to the confusion which exists in the nomenclature of lines. The subject fully treated would embrace the whole range of spectral analysis; but I must confine what I have to say to solar spectra.

In the early days of solar examination with the spectroscope, I made my venture, in the direction which I am now pursuing, and it failed. Ignorant that I was already distanced—no matter how or why—I suggested certain symbols for certain lines, foreseeing somewhat of what has come to pass. Aiming to avoid an affiliation which further knowledge might prove false, but admitting the great probability that the lines at C, F, 2796 (K) were really due to hydrogen, I would have called these solar bright lines α, β, γ, the hydrogen lines being already known as Hα, Hβ, Hγ; that which is now variously called "D_3," "D^3," "near D," or sometimes plain "D," I would have had known, in the same category, as δ. And other Greek letters expressed, and would have sufficed to express, as many more as the memory would require to hold. The venture failed, as I say; and considering that no little confusion has resulted, I cannot help thinking it a pity that it did. Soon after appeared a work on spectrum analysis, in which Hγ is ignored, and the bright solar line which corresponds with 2796 (K) and with Hγ is persistently called and identified with G, to the great scandal of the ghost of Fraunhofer and (I doubt not) the living Plücker. The blunder has often been repeated since, indeed I have seen it in NATURE more than once in the last few days. If it was not to have a Greek letter, at least it had a better right to be known as "2796 (K)" than has the coronal line to be called "1474 (K)." Failing that, it has been paraphrased, the shortest form being "near G." Surely it is time this were put right.

And now we have "1474." No one knows what the true position of that line is. The line 1474 (K) is an iron line, and it is to the last degree improbable that the coronal line is identical with it. The misnomer has carried with it, naturally, the idea that the source is iron. As this is an improbability of a higher order still—because there is evidence against it in the absence of a few hundred other iron lines—a false idea is in process of being fixed.

And all this arises, and much more will follow, from the laziness of mind, if I may so call it without offence, which adopts a name belonging to something already, instead of first reserving judgment, and giving it an independent standing with a name of its own.

Then there is the confusion of idea, and uncertainty in understanding exactly what is intended in speaking of the extension of the spectrum, and of position in it, as right and left, or left and right, as the case may be; or the confusion is avoided by the precise but cumbersome reference to degree of refrangibility. This is quite unnecessary. This is so exact an analogy between the *degree* of refrangibility and the *degree* of heat that no one

ought to experience the least difficulty in using the simple adjectives "higher" or "upper" and "lower" for the parts of the spectrum, and the simple prepositions "above" and "below," where required. There is no possibility of misconception, and no explanation is needed.

Probably we have got beyond the stage in which misconception is likely to arise from the careless use of words expressing continuity or otherwise in a spectrum; but I would suggest the word "diffuse" where it is not intended to express anything precise. Thus the coronal spectrum is diffuse until we know it to be solar. M. Janssen testifies to dark lines seen in the (diffuse) spectrum.

J. HERSCHEL

Camp Nandair, Hyderabad, March 19

Turner's Vision

I HAVE been waiting since the appearance of a report of Dr. Liebreich's lecture in NATURE of March 21 expecting that an animated discussion would be provoked, affording me an opportunity of slipping in obscurely as a minor combatant, the subject being one on which I am but very indifferently qualified to speak, although thirteen years ago I did incidentally suggest an explanation of the peculiarities of Turner's later pictures which, simple as it is, still appears to me sufficient. On page 67 of "Through Norway with a Knapsack," published in 1859, speaking of some of the peculiar midnight sunset effects of the North, I said that "Turner, like an eagle, has dared to face the sun in his full glare, and to place him in the middle of his pictures, showing us how we see a landscape with sun-dazzled eyes, when everything is melted into a luminous chaos, and all the details blotted out with misty brightness."

In all these peculiar pictures that I have seen the sun is thus placed in the middle of the picture, and just sufficiently above the horizon (from about 10° to 20°, or at most 25°) to pour his rays about perpendicularly to the curvature of the eye-ball, when the face is in position to contemplate a landscape. I have frequently repeated the experiment of contemplating a landscape under such circumstances, and on every occasion of submitting to such torture have seen all the effects of even the most extravagant of Turner's later pictures, which are so well described by Dr. Liebreich. I have seen the "vertical streakiness, which is caused by every illuminated point having been changed into a vertical line," with an "elongation, generally speaking, in exact proportion to the brightness of the light," and that "there proceeds from the sun, in the centre of the picture, a vertical yellow streak." These appearances may arise from an affection of the crystalline lens of my eye similar to that attributed by Dr. Liebreich to Turner, or it may be due to something else much simpler, and which is more or less common to all human eyes. If the simpler explanation based upon normal conditions covers the facts, it certainly must be the more acceptable.

My explanation of the vertical streaks is this. When we thus look full faced at the sun, the dazzle produces slight inflammation or irritation, and a flow of tears. The liquid accumulates, and rests upon the lower eyelid, forming a little pool, the surface of which has a considerable vertical curvature, *i.e.* the lower part of the retained tear curves upwards from the surface of its base at the root of the lower eyelashes to its summit contact with the conjunctiva. Thus in a vertical direction it must act as a lens of very short focus, it must refract and converge the rays of light in a vertical plane, and thus produce a vertical magnifying effect, the definition of which will of course be very confused and obscure, on account of the irregular curvature, and the fact that the eye is focused to the distant objects. This want of directive focusing will limit the distortion to the bright objects whose vertically magnified images will be forced upon the attention.

To test this explanation let any one select a bright afternoon, and at about 6 P.M. or a little later, at this season, gaze sunward upon any landscape free from London smoke or other medium of solar obscuration. At first, if his eyes are not very sensitive, he will see a circular sun, but presently, as the tears accumulate, the vertical elongation of the sun and general "vertical streakiness" will appear. When I tried the experiment last week the sun appeared like a comet with a brilliant vertical conical tail, the point of which rested on the horizon. But I was then slightly troubled with what is called "a cold in the head," and my eyes watered very vigorously, and thus the conditions for producing fine Turneresque effects were highly favourable. On carefully drying my eyes these effects were, for a moment, considerably diminished.

I have adopted another method of testing this explanation. Having caused the eyes to become somewhat suffused, I bring the upper and lower eyelids so near together that the liquid shall occupy a sensible depth, *i.e.*, from the conjunctiva to the base of both upper and lower eyelashes, and by compression be bulged or curved outwards in the vertical direction. On looking through this tear-filled chink at a gaslight, the vertical elongation is remarkably displayed, and it extends upwards or downwards or both according to the position of the liquid. When looking at the sun and landscape with the eyes fully opened (which is very painful), the elongation is chiefly downwards, and obviously connected with the tear on the lower eyelid; but if the eyelids be nearly closed to diminish the intensity of the light, an upward elongation is also commonly visible.

The other phenomena represented by Turner are, I think, simply a faithful copying of the effects of glare and suffusion produced by painful sun-gazing and the looking at a landscape where the shadows are, so to speak, nowhere, or all behind one's back.

W. MATTIEU WILLIAMS

The Adamites

As "M. A. I." prefers to keep his incognito, I shall not seek further to induce him to reveal himself. He has now, however, pointed out what he conceives to be errors in my paper, and I will reply to his criticism.

In the first place, as to the word *pi-ta*, I neither said nor inferred that the final syllable is not a suffix. My remark was that it retained a primitive root, *ta*, which is found also in the Semitic *'ata*, and I submit still that I am perfectly correct. The suffix *tár* in Sanskrit denotes nouns of agency, as Bopp shows in his "Comparative Grammar," and I am quite justified, when I find in various other languages a root word similar both in sound and sense, in inferring that the Sanskrit suffix was originally of the same character. I have hitherto been under the impression that comparative philology had established that suffixes were at one time independent words, but it appears that I am wrong. To show, however, that I have erred in good company, I would refer to Prof. Max Müller's "Stratification of Language" (p. 32), where it is said, "suffixes and affixes were all independent words, nominal, verbal, or pronominal; there is, in fact, nothing in language that is now empty, or dead, or formal, that was not originally full, and alive, and material." I must plead guilty of ignorance of "M. A. I.'s" scientific method.

As to *Taata*, when it is shown that *Tamata* or *Tangata* was the original form of the Polynesian deity's name, I shall be better able to reply to your correspondent's criticism. In any case, the final syllable is evidently the word denoting "spirit," and I see no difficulty in *Ta* becoming either *Tam* or *Tang* as the result of phonetic change. The mere fact that *Taata* and *Tiki* are different gods with different attributes really amounts to nothing, since such a division of personality and characteristics is a common fate of the divinities of heathen mythologies. I see no reason to change my opinion that the name of the Polynesian great ancestor has preserved the same primitive root as that which is to be found in the name of the first man, Adam, of the Semites, or rather of the *Akkad* forerunners.

While replying to "M. A. I.," it may be well to notice the criticism of his advocate, Mr. Jenkins, for whose explanation of the meaning of the word *Adam* I am much obliged, although, if he will take the trouble to read my paper, he will see that I was not ignorant of what he states. But the acceptance of the Hebrew meaning of the word as the original one does not lead me to place much reliance on Mr. Jenkins's judgment. If the Old Testament narrative proves anything beyond a knowledge of the tradition as to Adam, it is that the narrator was a bad philologist, and that finding the Hebrew word *adamah*, he forthwith inferred that the first man was made of ground-dust, which gave to him its red colour. For my part, I entirely ignore the authority on such a point of the Hebrew writer, and in justification I beg to refer to the statement made by the Rev. A. H. Sayce before the Society of Biblical Archæology, as reported in the last number of NATURE (p. 495), that the early Semitic traditions are derived from an Akkadian source, as are also most of the biliteral roots of the Semitic language. If the traditions are taken from that source, the probability is that the proper names they enshrine have had the same origin; and I submit, therefore, that I am quite justified in tracing the meaning of the word Adam to the old Chaldean tongue, in which, as Mr. Norris's Assyrian dictionary shows, and as my paper asserts, *Ad* signifies "a father."

In conclusion, I may add that there is nothing improbable to my mind in peoples even so distant from each other as the Polynesian Islanders and the Gauls retaining in their traditions a name which had been applied to their mythical common ancestor, nor unreasonable in supposing that they and other peoples mentioned in my paper were alike derived from some region in Central Asia. My argument is simply cumulative, as there are many facts of a different kind pointing in the same direction.

I am sorry my communication has reached such an inordinate length; but having replied to "M. A. I.'s" objections, which, after his first letter, forcibly remind me of the mountain in labour bringing forth a mouse, I shall not trouble you with further correspondence on a subject which I fear is far from interesting to a majority of your readers. C. STANILAND WAKE

Meteor

As I was going along the road towards Greystoke Castle at half-past eight P.M. on Friday last, April 19, I noticed a very fine meteor in a south-east direction. It was about the size of a common hand-ball, its centre being of an exceedingly brilliant white colour, surrounded by a circle of a bluish tinge, while short flickering radiations were distinctly visible on its circumference in all directions, reminding me of the sphero-stellate spiculæ of certain sponges. It was falling in a perpendicular direction, but I was not fortunate enough to see it at the beginning of its course. Its downward motion was slow and quite gradual, apparently not swifter than an ordinary india-rubber ball would fall by the gravity of its own body. There was no trail whatever left behind in its course. After two or three seconds it suddenly disappeared, before reaching the ground, without any explosion or expansion of its body. The night was very close and still, a muddiness covering the whole sky, interspersed here and there with long stratus clouds, and a beautiful halo surrounding the moon. THOMAS FAWCETT

Blencowe School, Cumberland, April 22

A Waterspout

ON Saturday last, April 16, whilst fishing in the river Elwy, at a point about two miles above the well-known Cefn caves, and five from St. Asaph by the river, I witnessed a very singular phenomenon. My attention was suddenly called up-stream by a remarkably strange hissing, bubbling sound, such as might be produced by plunging a mass of heated metal into water. On turning I beheld what I may call a diminutive waterspout in the centre of the stream, some forty paces from where I was standing. Its base, as well as I could observe, was a little more than two feet in diameter. The water curled up from the river in an unbroken cylindrical form to a height of about fifteen inches, rotating rapidly, then diverged as from a number of jets, being thrown off with considerable force to an additional elevation of six or seven feet, the spray falling all round as from an elaborately arranged fountain, covering a large area. It remained apparently in the same position for about forty seconds, then moved slowly in the direction of the right bank of the river, and was again drawn towards the centre, where it remained stationary as before for a few seconds. Again it moved in the former direction, gradually diminishing and losing force as it neared the bank, and finally collapsed in the shallow water. Strange to say, its course was perpendicular to the bank and not with the current.

At the time of the occurrence the river was still high, from the recent heavy rain, though the depth of water at the spot where I first observed it was not more than four feet. The current, of course, was stronger than usual, but presented a comparatively smooth surface. The day was fine and sunny, with a slight breeze from the S.E. The event occurred about 12.15, and lasted seventy or eighty seconds, as well as I could judge. The atmosphere in the immediate vicinity seemed, from the way in which the spray was scattered, to be somewhat agitated; but my impression was that such agitation was the result of the phenomenon, rather than its cause. I had fished over the spot a few minutes previously, and examined it afterwards with great care, but saw nothing to account for the wonder.

St. Beuno's College, St. Asaph, April 9. J. GRAY

Cuckoo's Eggs

THE discussion raised by Prof. Newton on the coloration of cuckoos' eggs has been very interesting doubtless to many readers of NATURE; a mite of information from New Zealand, concerning one species of the Cuculidæ, may not be out of place.

The German theory that "the egg of the cuckoo is approximately coloured and marked like those of the birds in whose nest it is deposited, that it may be less easily recognised by the foster parents as a substituted one," does *not* hold good in respect to our *Chrysococcyx lucidus*, Gml., pipiwharaupa, the whistler or small cuckoo.

The dupe is the piripiri, or gray warbler, *Cuygone flaviventris*, Gray, its eggs are white, dotted with red spots; the egg of the whistler of much larger size, is of a greenish dun.

However, I think it should be stated that the nest of the dupe is somewhat of a pear-shaped structure, firmly and thickly built, with a small entrance near the middle, well sheltered with feathers. Here discrimination betwixt eggs may be difficult for the foster parent, if it possesses the faculty and uses it. In the Trans. N. Z. Institute (vol. ii. pp. 58 and 65) reasons have been advanced by the writer for the selection of the warbler's nest by our brightly plumed cuckoo; may "the dim obscure" of its interior supply another reason? THOMAS H. POTTS

Ohinitahi, Feb. 5

Sun-spots and the Vine Crop

As the connection of sun-spots with terrestrial phenomena is now largely occupying the attention of scientific men, the following facts may be of some interest. The years in which the wine crop in Germany was unusually good seem (in this century, at least) to have returned at regular intervals. The close coincidence of these years with the years of minimum sun-spots is shown by the following table:—

Minimum of Sun-spots.		Wine-years.	Minimum of Sun-spots.		Wine-years.
1784·8	...	1784	1833·8	...	1834
1798·5	...	(?)	1844·0	...	1846
1810·5	...	1811	1856·2	...	1857
1823·2	...	1822			1858
			1867·2	...	1868

I may add that the gentleman who first remarked the regular recurrence of wine-years at intervals of about eleven years was not aware of the periodicity of the sun-spots, and could not therefore have been in any way prejudiced. The years given in the above table are the only ones known in Germany as good wine-years.

These facts agree with the results of Messrs. Piazzi Smyth and Stone, who found that the mean temperature on the surface of the earth was subjected to a period of eleven years.

ARTHUR SCHUSTER

Owens College, Manchester, April 23

Tide Gauge

IN NATURE of the 18th is a letter from Mr. Pearson respecting Tide Gauges. As very little appears to be known of such instruments, we beg to inform you that we have made them for many years, and have now two finished, one for the Indian Government, and the other for the Australian Government, and we shall be happy to show them to any one wishing to see them. We think they could be made self-acting at a much less cost if the *exact* time of high water is not required.

449, Strand, W.C., April 19 ELLIOTT BROTHERS

Colour of the Hydrogen Flame

IN a communication from my zealous science-master, which I find in your issue of Thursday the 11th, it is stated that pure hydrogen has *no* tinge of blue in its flame (that colour being due to the presence of sulphur), and he concludes his note with a gushing tribute of his own, and the younger boys' gratitude for the "simply delightful Science Primers of Profs. Huxley, Roscoe, and Balfour Stewart." Let me call his attention to the fact that on page 26 of his Chemistry Primer, Prof. Roscoe distinctly states that "Hydrogen is inflammable, and burns with a pale blue flame." A GRATEFUL PUPIL OF MR. BARRETT

The "Cheironectes pictus"

SINCE I communicated to you an account of a fish which I caught in the Gulf weed during the homeward voyage of H.M.S. *Charybdis*, I have seen, in the February number of the *American*

Journal of Science and Arts, a description of a fish-nest which Prof. Agassiz obtained from the seaweed of the Sargasso Sea in December last.

In this interesting paper Prof. Agassiz identifies the embryos which he acquired from the nest as the young of the *Cheironectes pictus*, which, as its name implies, has fins like hands. From the description given I have no doubt but that my specimen is the *Cheironectes*, and I lose no time in forwarding to you the result of my reading. J. E. MERYON

H.M.S. *Duke of Wellington*, Portsmouth

OCEAN CURRENTS

IN the *Philosophical Magazine* for October 1870 and 1871 I have examined at considerable length the arguments which have been advanced in favour of the theory that Oceanic Circulation is due to differences of specific gravity between the ocean in equatorial and polar regions. Since then a point in reference to the influence of the earth's rotation has suggested itself to my mind which appears to be wholly irreconcilable with the gravitation theory of currents.

It is one of the properties of a fluid that the resistance which it offers to motion is equal in all directions. It follows, therefore, that when an ocean current is flowing in any particular direction, the forces acting on the moving water must be greatest in the direction of motion. According to the theory that oceanic circulation is due to difference of specific gravity, resulting from the difference of temperature between the equatorial and polar waters, the direction of motion at the surface of the ocean is from the equator to the poles, and at the bottom from the poles to the equator, subject to a deflection caused by the earth's rotation. According to this theory gravity tends to impel the water from the equator towards the poles along the line of meridian; while rotation tends to deflect the water towards the east. If the total amount of work performed on the moving water by these two forces were equal, then the water on the northern hemisphere would take a north-easterly direction, and that on the southern hemisphere a south-easterly direction. But owing to the way in which the two forces vary in relation to each other, the path taken is not a straight line but a curve, the particular character of which has been determined with great labour by Mr. Ferrel.

But whatever view we may adopt in regard to the influence of rotation on the moving waters, whether it be that advocated by Dr. Colding and others, or that propounded by Mr. Ferrel, it is evident that if we assume the amount of the impelling energy of gravity to be not greater than the deflecting energy of rotation, we shall be led to the conclusions that there can be no such general interchange of equatorial and polar water in the Atlantic as Dr. Carpenter maintains. For under such conditions water leaving the equatorial regions for the Arctic seas would move as rapidly eastward as northward, and would consequently be deflected against the western coast of the old continent, and arrested in its progress before it reached even the latitude of England.

I need not, however, dwell further on this point, for I do not suppose there are any advocates of the gravitation theory who will not freely admit that the impelling energy is at least equal to the deflecting energy, and if this be admitted, it is all that is necessary for my present argument.

What proportion then does the impelling energy of gravity bear to the deflecting energy of rotation?

The velocity of rotation at the equator is about 1,526 feet per second, and at lat. 60°, about 773 feet per second. Were water frictionless, and did it offer no resistance to motion, then a pound of water flowing from the equator in the direction of the pole would, on arriving at latitude 60°, have, according to hitherto received ideas, an easterly velocity relative to the earth's surface of 763 feet per second. Mr. Ferrel has, however, shown that the relative velocity would be much greater. But not to run the risk of over-estimating the velocity, I shall be content to take it at 763 feet. Water flowing from the equator towards the poles, instead of having an actual velocity of 763 feet per second on reaching latitude 60°, has, at the utmost, a velocity not over one or two feet. If we suppose the velocity to be, say, 3 feet per second, then 760 feet per second of velocity derived from rotation is consumed by friction and other resistances in the passage of the water from the equator to that place. A pound of water moving with a velocity of 760 feet per second possesses in virtue of that velocity 9,025 foot-pounds of energy. This enormous amount of energy is all consumed, not in impelling the pound of water from the equator to latitude 60°, but in simply deflecting it to the east during its motion. Consequently 9,025 foot-pounds is the amount of energy required to perform the work of deflection. But since the resistance offered by a fluid to motion is equal in all directions, the resistance offered to the impelling force must be as great as that offered to the deflecting force. It is, I trust, admitted that in the passage of the pound of water from the equator to latitude 60°, the distance traversed by the water under the influence of the impelling force is as great as the distance traversed under the influence of the deflecting force, or, in other words, the distance from the equator to latitude 60°, measured along the meridian, is as great as the distance to which the water is deflected to the east during its passage. Then, if this be the case, 9,025 foot-pounds of energy of the impelling force must be also consumed in overcoming the resistance to the motion of the pound of water; that is, the impelling force requires to perform 9,025 foot-pounds of work before it can convey a pound of water from the equator to latitude 60°. Can gravitation, therefore, be the impelling force? Can gravity, according to Dr. Carpenter's theory, perform 9,025 foot-pounds of work on a pound of water in impelling it from the Equator to latitude 60°?

Taking Dr. Carpenter's own data as to the temperature of the ocean at the poles and equator, and the rate at which the temperature at the equator decreases from the surface downwards, I have shown* that 9 foot-pounds is the greatest amount of work which gravity can perform on a pound of water (placed under the most favourable circumstances) in carrying it from the equator to either pole. Assuming the slope from the equator to the poles to be uniform, 6 foot-pounds will be the total amount of work that gravity can perform upon a pound of water in its passage from the equator to lat. 60°. But this is only $\frac{1}{1500}$ part of the amount of energy required. Hence, if there is any circulation of water between the equatorial and polar regions, it must be produced by a cause 1,500 times more powerful than the one to which he appeals.

But in reality the amount of energy impelling the water must be far more than 1,500 times greater than what can be derived from gravity, for the water moves more in the direction of the impelling force than in the direction of the deflecting force, thus proving that the impelling force is greater than the deflecting force.

Although it will be admitted that the resistance offered by fluid friction is equal in all directions, yet it may be urged that, owing to the influence of the winds or some other cause or causes which I have not taken into account, the actual resistance to motion may be greater in some directions than others. This no doubt may be the case, but it cannot possibly affect the conclusion at which I have arrived, unless it be shown that the resistance to pole-ward motion is 1,500 times less than the resistance to eastward motion.

But these results are as conclusive against the theories of Maury, Colding, Ferrel, and in fact against every possible form of the gravitation theory, as against the theory of Dr. Carpenter. And I need hardly add that they are equally fatal to the theory that ocean currents are caused

* Phil. Mag., Oct. 1871.

by the heaping up of the water by the winds; for any amount of power which could possibly be derived from such a source must fall enormously short of that required.

It may be noticed that we have here a means of making a somewhat rough estimate of the absolute amount of resistance offered to oceanic circulation, a rather obscure point. It shows that the resistance to motions arising from friction is far greater than was hitherto supposed. The amount of the work of the resistance to a pound of water passing from the equator to lat. 60° cannot be less than twice 9,025 foot-pounds.

It follows also that if the resistance to motion in the waters of the ocean be as great as it has thus been proved to be, then there is no warrant for the generally received opinion that a force such as that of the winds acting on the surface of the ocean cannot produce motion extending to any considerable depth. For if the resistance to motion be as great as the foregoing consideration shows it to be, it is impossible that the upper layers of the ocean can be constantly pushed forward in one direction without dragging the underlying layers after them.

The inadequacies of the gravitation theory may be shown in an even still more striking manner. Conceive a column of water in any part of the ocean extending from the surface to the bottom. Suppose the column to be a foot square, and the depths of the ocean to be four miles. We have in this case a column a foot in thickness, and four miles in height measured from its base. According to Dr. Carpenter's theory, gravity tends to move the water forming the upper part of the column in the direction from the equator to the pole, and the water forming the under part from the pole to the equator. What then is the amount of force exerted by gravity on the entire column? In the next part of my paper on Ocean Currents in the *Philosophical Magazine* I shall demonstrate by an exceedingly simple and obvious method, that the total amount of force exerted by gravity on the whole mass of water constituting the column is only $\frac{9}{16}$ of a grain. That is, $\frac{9}{16}$ of a grain on 600 tons of water.

Edinburgh, April 15 JAMES CROLL

THE FOSSIL MAMMALS OF AUSTRALIA

THE substance of this communication was given orally at the meeting of the Royal Society, April 18, 1872.

Prof. Owen commenced by alluding to the series of fossils brought in 1836 by the then Surveyor-General of Australia, Sir Thomas Mitchell, from the bone caves discovered by him in Wellington Valley, New South Wales. The determination of these remains required study of the osteology and dentition of the existing marsupial animals, which formed the subject of papers in the "Transactions of the Zoological Society" (vol. ii., 1838, and vol. iii., 1845).

In these papers indications were given of a second species of living wombat, distinct from the type peculiar to Tasmania, such indications being yielded by a skull sent from Australia. In 1853 the author published, in his "Osteological Catalogue of the Museum of the College of Surgeons," the cranial characters of a third living species of *Phascolomys*, also from a skull, which, like that of the second species, was from the continent of Australia. These materials seemed to some naturalists inadequate for the acceptance of a *Phascolomys latifrons* and a *Phascolomys platyrhinus*, in addition to the first discovered Tasmanian *Phascolomys vombatus;* and Gould in the part published in 1855 of his great work, "The Mammals of Australia," containing the fine figure of that species, hesitated to admit more, although a drawing which he had received of the head of a wombat killed in South Australia "afforded good reason for concluding that the continental animal is really distinct." In 1859 this distinguished naturalist was able to publish in Part XI. of his work a figure of a wombat from the southern parts of the continent of Australia, which he recognised as distinct from the small wombat of Tasmania, and referred to the *Phascolomys latifrons;* it was, however, the larger bare-nosed species, *Phascolomys platyrhinus.*

In 1865 and 1866 specimens were received at the Zoological Gardens of London, of both the continental Australian wombats, which the able Prosector, Dr. Murie, showed to have respectively the cranial characters of *Phascolomys latifrons* and *Phasc. platyrhinus.* The *Ph. latifrons* had the nose or muzzle clothed with hair. This confirmation greatly encouraged the speaker in the investigation and comparison of the cranial and dental characters of the fossil remains of the genus; and in November 1871, he felt that he had grounds for submitting to the Royal Society such characters of four other species of wombat, not exceeding in size the largest of the existing kinds, which four species appeared to have become extinct on the continent of Australia. The differentiation of the actual platyrhine and latifront species from some of the extinct forms was not the less interesting and instructive; though it seemed small in degree, it was, however, definite, in comparison with other fossil remains which could not be distinguished from the existing *Phascolomys platyrhinus* and *Ph. latifrons.*

The determination of the species propounded on cranial and dental characters in the present paper was much easier and more decisive, by reason of the marked superiority of size of the fossils. These large and gigantic wombats were differentiated, not only by bulk, but by modifications of the skull and proportions of certain teeth, notably the incisors and premolars.

On these grounds the author characterises a *Phascolomys medius*, which, although markedly larger than *Phascolomys platyrhinus*, was intermediate in bulk between the two now known extremes of size in the genus. Next followed a *Phascolomys magnus*, and finally a *Phascolomys gigas.* Of the latter species a restoration was given in a diagram of the natural size, which was that of a tapir or small ox. The dental and certain cranial characters were illustrated by highly finished drawings of the fossils.

With respect to the large extinct wombats described in his present paper, the author remarked that it was not likely they could have escaped detection if still existing in any of the explored parts of the Australian Continent. The knowledge that such species have existed may excite to research and help to their discovery, if any of them should still be in life, in the vast tracts of the northern and warmer latitudes of Australia.

The author exhibited in a tabular view the localities of the known existing and extinct Australian wombats as follows:—

Where found	By whom found	Species of Phascolomys.
Breccia Cave, Wellington Valley, N. S. Wales	Sir Thomas Mitchell, C.B., 1836	*Mitchelli*
Lacustrine Bed, Victoria	E. C. Hobson, M.D., 1845...	*Gigas*
Drift Deposits, Queensland ...	Geo. Bennett, M.D., F.L.S., 1861	*Mitchelli*
Ib. King's Creek, Darling Downs	S. Turner, 1847 ...	*Parvus, Medius*
Ib. Gowrie, *Ib.*	Fred. Neville Isaac, 1861	*Mitchelli*
Ib. Eton Vale, *Ib.*...	Ed. S. Hill, 1865 ...	*Platyrhinus, Medius, Magnus, Gigas*
Ib St. Jean Station, *Ib.*	M. Satche St. Jean, 1864...	*Gigas*
Ib. Drayton, Queensland	Sir Danl. Cooper, Bt., 1865...	*Thomsoni, Medius Magnus, Gigas*
Freshwater Beds, Clifton Plains, *Ib.*...	F. Nicholson, 1866 ...	*Gigas*
Caves, Wellington Valley, N.S. Wales	Professor Thomson, G. Krefft, 1867	*Mitchelli, Kreffti, Latifrons*

The author then touched upon some generalisations suggested by the present stage of discovery. The disappearance of the larger species was explicable on the principle of the "contest of existence," as applied by him to the problem of the extinction of the fossil birds of

* "On the Fossil Mammals of Australia," No. VIII.: Genus *Phascolomys;* species exceeding the present in size, by Prof. Owen, F.R.S.

New Zealand (Trans. Zool. Soc., vol. iv., 1850), and subsequently by Darwin to the incoming of new species, as "the battle of life." He next entered upon the relation of the present discoveries in Australia to the law of Geographical Distribution in the new Tertiary or Quaternary periods of extinct and existing animals.

The wombat was a more characteristic Australian form of mammal than the kangaroo, for the latter is represented by species in New Guinea; and species of *Phalanger* range farther from Australia, though still bound to the same great natural, and mainly submerged, division of the earth's surface. But no kind of wombat, recent or fossil, has been detected out of Australia and Tasmania. The present Continental kinds, and species near akin to them, existed in Australia during a very long period, reckoned by the terms of historical time, if we may judge from the state of petrifaction of the fossils, and the great depths at which some have been met with in well-digging; where, after 30 ft. or 40 ft. of black rich soil have been bored through, such fossils occur at 100 ft. lower down in sandy drift, which has been accumulated to that or greater vertical thickness beneath the loam. On the assumption that air-breathing animals perished in a general deluge some 5,000 years ago, and that their dispersion then began anew from the exceptional few individuals preserved in the Ark, we must suppose the wombats then living in Australia to have contributed miraculously their pair or pairs to the Asiatic menagerie, and to have been as miraculously restored to their proper continent on the subsidence of the Noachian flood.

It is neither creditable nor excusable that so great a divergence should still be maintained, chiefly through theological teaching, in the ideas of the majority of men "of ordinary culture" as to the cause and conditions of the distribution of living species over the globe, from those suggested by the clear and multiplied demonstrations of Science. On this topic the author referred to a paper in "Annals and Magazine of Natural History," 1850, "On the Gigantic Birds of New Zealand, and on the Geographical Distribution of Animals."

*THE CONNECTION BETWEEN COLLIERY EXPLOSIONS AND WEATHER**

AFTER a preliminary reference to previous papers on the subject, and especially to the diagrams published by Mr. Joseph Dickinson, and by Mr. Bunning, of Newcastle-on-Tyne, the authors of the paper referred specially to Mr. Dobson's paper, published in the reports of the British Association. They showed that the periodicity alleged by him to exist in these explosions had no real foundation in fact; for, on plotting the dates of the explosions for the last twenty years in two ten-year periods, very slight resemblance was seen between the two curves. The number of accidents (all fatal ones) on which the statement was based was 1,369.

In the progress of this inquiry it had come out that the number of serious accidents, involving the loss of ten lives or more, had materially increased during the last five years, the numbers being :—

1851-55	13.	1856-60	15.
1861-65	12.	1866-70	21.

These numbers appear to be well worthy of remark.

For the special purpose of the paper, the continuous records from Stonyhurst, one of the observatories in connection with the Meteorological Office, were taken, and the curves for the barometer and thermometer were plotted for the three years, 1868-70. The records of fatal explosions were obtained from the published reports of the inspectors, while the dates of the non-fatal accidents were obtained from the inspectors themselves, who, almost without exception, replied to the communications addressed to them, and furnished the desired information.

Mr. Dobson, in his paper, having spoken of the explosions occurring principally at the commencement of a storm, the authors showed that it was not, in some cases, until two or three days after the barometer had reached its lowest point that the accident happened. They showed also why, during a period of continued violent oscillation of the barometer, the passage of each successive barometrical minimum is not characterised by an equal number of explosions, the largest groups of accidents being reported when a serious break occurred after a period of calm weather.

The effect of a high temperature of the air in interfering with ventilation, and especially with natural ventilation, was also explained, and it was shown how the first hot days in spring were marked by explosions.

The actual dates of the explosions for the three years in question were then compared with the meteorological records, and it was shown that out of 550 explosions—

266, or 48 per cent.,		might be attributed to the state of the barometer;
123, „ 22	„	to the state of the thermometer;
161, „ 30	„	remained unaccounted for on meteorological grounds.

The next point touched upon in the paper was the action of a more or less impure ventilating current in increasing the explosive character of the air in all parts of the pit, and possibly in causing an explosion in a place which would have remained safe had the ventilating current itself remained pure. It was shown how, when an explosive mixture had been formed in places and under conditions similar to those described, some time, possibly several days, must elapse before the contents of such an accumulation of dangerous gases shall have been rendered innocuous again.

The effect of warm weather in stopping natural ventilation was explained. The natural temperature of a mine of the depth of 50 fathoms being 55°, that of one of the depth of 200 fathoms 70°, and so on (speaking generally), it was shown that if the temperature of the air rose to 55° natural ventilation must cease in shallow pits, and similarly in other cases. Accordingly, if a warm day occurs in the cold season of the year, and the furnaces are not in action, an explosion is very likely to occur.

These statements were illustrated by one instance of a fatal explosion, the cause of which had been declared by the inspector to be inexplicable, the pit having "strong natural ventilation." It appeared, however, that the explosion occurred on a warm day, while the inspector visited it twice on colder days after the explosion; so that the state of ventilation which he witnessed had no reference to that which must have prevailed when the accident happened.

The paper concluded by stating that it appeared that the evidence fairly justified the view that meteorological changes are the proximate causes of most of the accidents, it being remembered, as has before been observed, that the records contain no account of the number of times when the pits have been too dangerous for the men to go down, and so explosions have not happened.

Whatever be the meteorological changes, it is absolutely necessary to keep a most careful watch over the amount of air passing through the workings.

Thirty years ago George Stephenson said, in a letter to the South Shields Committee, referring to explosions :— "Generally speaking, there has been some fault in the ventilation of the mines when accidents have occurred;" and the same opinion is held by many of the most experienced authorities at the present day. In this matter the one cry, whether we look to security against explosion, or to the affording to miners an atmosphere which they can breathe without injury to health, is "More air!"

* "On the Connection between Colliery Explosions and Weather," by Robert H. Scott, F.R.S., and Mr. W. Galloway. Read at the meeting of the Royal Society, April 18, 1872.

THE TEMPERATURE OF THE SURFACE OF THE SUN

IT will be recollected that Messrs. M. E. Vicaire and Sainte-Claire Deville read some papers before the Academy of Sciences at Paris last January, showing that the temperature of the solar surface does not exceed that produced by the combustion of organic substances. Their reasoning being based on the law of radiant heat established by the investigations of Dulong and Petit. I have in the meantime instituted a series of experiments on a comparatively large scale, in order to test the correctness of the said law. Accordingly, the dynamic energy developed by the radiation of a mass of fused iron weighing 7,000 pounds raised by "overheating" in the furnace to a temperature of 3,000° F., has been carefully measured.

Sir Isaac Newton assumed that the quantity of heat lost or gained by a body in a given time is proportional to the difference between its temperature and that of the surrounding medium. Some eminent scientists, however, accepting Dulong's conclusions and formula, assert positively that the stated assumption is incorrect. In so doing they apparently overlook the conditions inseparable from the Newtonian doctrine, namely, that the conducting power of the radiating body should be perfect; that at every instant the temperature pervading the interior mass should be transmitted to the surface.* It needs no demonstration to prove that if the conducting power of a body be so perfect that the temperature of the centre is at all times the same as that of the surface; in other words, that the fall of temperature at the centre, occasioned by radiation, is as rapid as the fall of temperature at the surface, the rate of cooling of such a body will be very different from that observed by Dulong and Petit. The investigation instituted by those experimentalists has in reality established only the degree of conductivity of the radiators employed, under certain conditions, but by no means their true radiant energy at given temperatures. M. E. Vicaire and Sainte-Claire Deville, therefore, commit a serious mistake in assuming that the *quantity* of heat transmitted by the radiation of incandescent bodies at high temperatures has been determined. It may be observed that the relation between the time of cooling and the *quantity* of heat transmitted by radiation which Dulong and Petit established, also misled Pouillet regarding the temperature of the solar surface, which he computed at 1,461° C., or at most 1,761° C. It will be well to bear in mind that Pouillet had himself ascertained with considerable accuracy the temperature produced by solar radiation on the surface of the earth; and also the retardation suffered during the passage of the rays through the terrestrial atmosphere. He was therefore able to demonstrate that the dynamic energy developed by solar heat amounts to nearly 300,000 thermal units per minute for each square foot of the surface of the sun. Considering the imperfect means employed by Pouillet, his "pyrheliometre," the exactness of his determination of solar energy is remarkable. The truth is, however, that the near approach to exactness was somewhat fortuitous, the eminent physicist having underrated the energy of radiant heat on the surface of the earth, while proportionately over-estimating the retarding influence of the terrestrial atmosphere. The true dynamic energy developed by radiation at the surface of the sun, exclusive of the absorption of the solar atmosphere—no doubt exceedingly small—determined by the solar calorimeter mentioned in a previous article, is 312,500 thermal units per minute upon an area of one square foot. It will be proper to notice that this amount is not a mean result of a number of observations, but the greatest energy developed at any time during observations continued upwards of three years, namely February 28, 1871. It will be proper to add that this result has been withheld from publication until it could be verified by a second observation indicating an equal energy. Fortunately the sky at noon, March 7, 1872, proved to be as clear as on the previous occasion referred to, the indicated energy differing only a few hundred units from that developed February 28, 1871.

Temperature being a true index of molecular and mechanical energy, conclusively established by the exact relation between the degree of heat and the expansive force of permanent gases under constant volume, it is surprising that Pouillet did not perceive that an intensity of 1,461° C. or 1,761° C., could not possibly develop on a single square foot of surface the enormous energy represented by 300,000 thermal units per minute. M. Vicaire, adopting like Pouillet Dulong's formula, states in the paper presented to the French Academy that "an increase of 600° is sufficient to increase the radiation a hundred fold;" and that Pouillet has verified Dulong's law to more than 1,000°. "Supposing," he observes, "that beyond this temperature the law ceases to be true, it cannot be absolutely remote from the truth for the temperatures of from 1,400° to 1,500° which we deduce by adopting the law." Sainte-Claire Deville concludes his essay on solar temperature thus:—"In accordance with my first estimate I believe that this temperature will not be found far removed from 2,500° to 2,800°, the numbers which result from the experiments of M. Bunsen, and those published long ago by M. Debray and myself." The French *savans* then agree that the temperature of the surface of the sun does not exceed the intensity produced by the combustion of organic substances, their grounds for this assumption being, as we have seen, Dulong's formula relating to the velocity of cooling at high temperatures. But Dulong and Petit did not carry their investigations practically beyond the temperature of boiling mercury; hence their formula relating to high temperatures is mere theory, the soundness of which we have now been enabled to test most effectually by measuring the radiant power of a mass of fused metal raised to a temperature of 3,000° F., 30 inches in depth, presenting an area of 900 square inches.

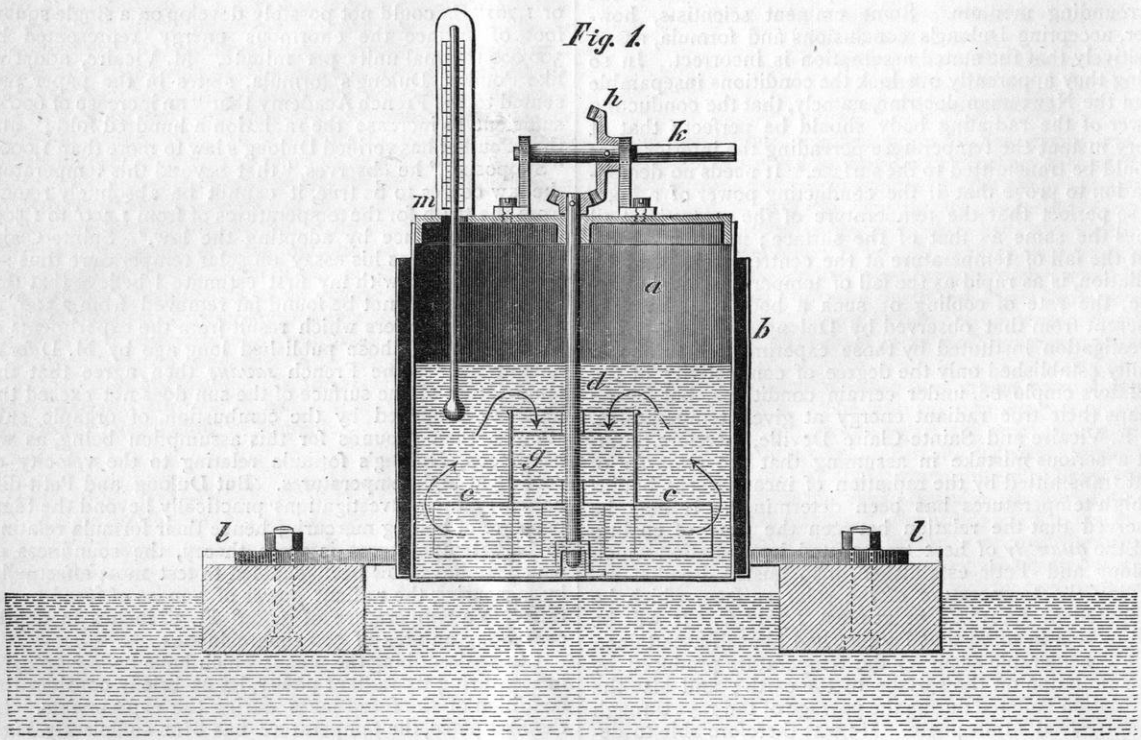
Before describing the means which have been employed in measuring its radiant power, let us briefly consider the condition of the fused mass during the experiments. In the first place, the temperature has been sufficiently high to produce an intense white light, luminous rays of great brilliancy being emitted by the radiant surface during the trial; (2) the bulk of the fused mass being adequate, the intensity of radiation has been sustained without appreciable diminution during the time required for observation; (3) the temperature being higher than that which the French investigations assign to the surface of the sun, while the bulk, as stated, is sufficient to maintain the temperature of the fused mass, it may be reasonably asked, why an area of one square foot of our experimental radiator should not emit as much heat in a given time as an equal area on the solar surface, if its temperature be that assumed by Pouillet? It may be positively asserted, moreover, that an increase of the dimensions of our radiator to any extent, laterally or vertically, could not augment the intensity or the dynamic energy developed by a given area. Again, Dulong's formula, as applied by scientists, shows that the emissive power of a *metallic* radiator raised to a temperature of 3,000°, reaches the enormous solar emission computed by Pouillet.

Let us now briefly examine the calorimeter constructed

* The writer has just completed a set of experiments with a spherical radiator, 2·75 in. in diameter, composed of very thin hammered copper, charged with water kept in motion by a wheel applied within the sphere, revolving at a rate of 30 turns per minute, the centrifugal action of which brings the particles of the central portion of the fluid so rapidly in contact with the thin spherical shell, that the apparently absurd condition of perfect conductivity has been practically fulfilled. The result of carefully conducted experiments with this radiator, enclosed in an exhausted vessel kept at a constant temperature, has established that Newton's law relating to radiant heat, up to a differential temperature of 100° Fahr. (beyond which the investigation has not extended), is rigorously correct. The subject will be fully discussed in a future article.

for ascertaining the mechanical energy developed by the radiation of the fused mass under consideration. Fig. 1 represents a vertical section, and Fig. 2 a perspective view. *a* is a cylindrical boiler, having a flat bottom, composed of thin sheet-iron 0·012 inch thick, coated with lamp-black. The cylindrical part of this boiler is surrounded by a concentric casing *b*, the intervening space being filled with a fire-proof non-conducting substance. A horizontal wheel, *c c*, provided with six radial paddles, is applied within the boiler, attached to a vertical axle, *d*. An open cylindrical trunk, *g*, is secured to the perforated disc which supports the paddles. The vertical axle passes through the top of the boiler, a conical pinion being secured to its upper termination. By means of a vertical cog-wheel, *h*, attached to the horizontal axle *k*, and geared into the conical pinion, rotary motion is communicated to the paddles. The centrifugal action of the latter will obviously cause a rapid and uniform circulation of the water contained in the boiler—indispensable to prevent the intense radiant heat from burning the bottom. The boiler and mechanism thus described are secured to a raft, *l l*, composed of fire-bricks floating on the top of the fluid metal. By this means it has been found practicable to keep the bottom of the boiler at a given distance, very near the surface of the fused mass, while by moving the raft from point to point, during the observation, irregular heating resulting from the reduction of temperature of the surface of the metal, under the bottom of the calorimeter, has been prevented. The radiant heat being too intense to admit of the axle *k* being turned directly by hand, an intervening shaft, eight feet long, provided with a crank handle at the outer end, has been employed for keeping up the rotation of the paddle-wheel during the trial. It is scarcely necessary to observe that, the intervening shaft should be coupled to the gear work by means of a "universal joint," to admit of the necessary movement of the raft. The experiment, repeated several times, has been conducted in accordance with the following explanation. The boiler being charged,

Fig. 1.



the paddle wheel should be turned at a moderate speed while observing the temperature of the water, the thermometer employed for this purpose being introduced through an opening, *m*, at the top of the boiler. The temperature being ascertained, the instrument should be quickly placed on the raft, and the time noted. As soon as vapour is observed to escape through the opening at *m*, the instrument must be instantly removed, the time again noted, and the temperature of the water within the boiler ascertained. It will be well to keep the paddle-wheel in motion until the last observation has been concluded.

The temperature of the fused metal having been as high during our experiments as that of the solar surface computed by Pouillet and his followers, while the thin substance composing the bottom of the calorimeter has been brought almost in contact with, and consequently received the entire energy transmitted by, the radiant surface, the reader will be anxious to learn what amount of dynamic energy has been communicated in a given time, on a given area. The desired information is contained in the following brief statement:—The necessary corrections being made for heat absorbed by the materials composing the paddle-wheel, &c., the instituted test shows that the temperature of a quantity of water weighing 10 pounds avoirdupois has been elevated 121° F. in 164 seconds (2·73 minutes), the area exposed to the radiant heat being 63 square inches. Hence a dynamic energy $\frac{10 \times 121}{2{\cdot}73} \times \frac{144}{63} = 1013$ thermal units per minute, has been developed by the radiation from one square foot of the surface of the fused metal maintained at 3,000° F., against 312,500 units developed by the radiation of one square foot of the solar surface, the temperature of which, agreeably to the calculations of the French *savans*, is less than that of our experimental radiator.

Having thus ascertained practically the amount of dynamic energy developed by the radiation of a metallic body raised to the high temperature of 3,000°, we have only to show in a similar manner the amount of energy

developed by a metallic radiator of a low temperature, to be enabled to demonstrate the correctness or fallacy of Dulong's formula. Numerous experiments have been made for this purpose with apparatus of different forms, the results having proved substantially alike. The device most readily described consists of a spherical vessel charged with water, suspended within an exhausted spherical enclosure kept at a constant temperature. Repeated trials show that, when the differential temperature is 65°, the enclosure being maintained at 60°, while the sphere is 125°, the dynamic energy transmitted to the enclosure by a sphere the convex area of which is one square foot, amounts to 5·22 thermal units per minute. The accuracy of this determination is confirmed by the fact that during the summer solstice at noon, when the sun's differential radiant intensity is 65°, the solar calorimeter indicates a dynamic energy of 5·12 units per minute on one square foot of surface.

Our practical investigations, then, show that a differential temperature of 3,000° developes by radiation a dynamic energy of 1,013 thermal units per minute upon an area of one square foot; and that a differential temperature of 65° develops 5·22 units per minute upon an equal area. The ratio of radiant energy at the first mentioned intensity will therefore amount to $\frac{1013}{3000} = 0{\cdot}337$ units for each degree of differential temperature; while for the low intensity it will be $\frac{5{\cdot}22}{65} = 0{\cdot}080$ unit for each degree of differential temperature. Consequently, the ratio o the radiating energy will be $\frac{0{\cdot}337}{0{\cdot}080} = 4{\cdot}21$ times greater at 3,000° than at 65°. Now, M. Vicaire, on the authority of Dulong, states that the ratio will be a hundred fold greater for an increase of only 600°. According to Newton's theory, based on dynamic laws, the proportion between the differential temperature and the radiant energy of bodies is constant; while Dulong and Petit, basing their conclusions upon an erroneous estimate of the time of cooling, assert that the ratio of energy increases

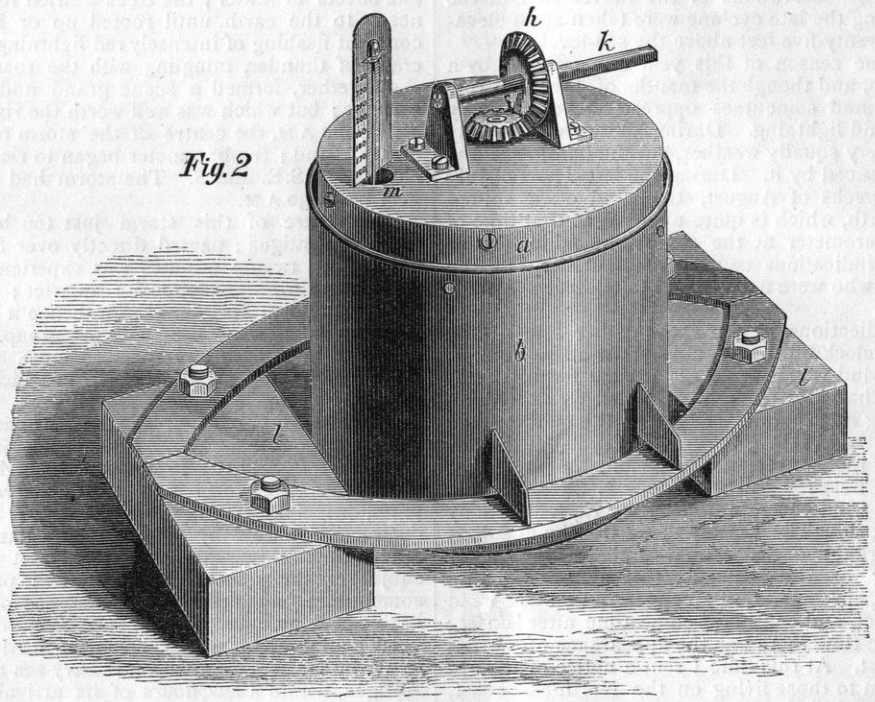


Fig. 2

several thousand times when the temperature is increased from 65° to 3,000°. Newton, then, as our experiments prove, is incomparably nearer the truth than the French experimenters; and possibly future research will prove that his law, when properly applied, will be found absolutely correct. It should be mentioned that the result of our experiments with the fused metal, compared with the result of other experiments with solid metals at various temperatures, show that the emissive power of cast iron is relatively greater in a state of fusion than when solid, or merely incandescent. This observed increase of emissive power, now being thoroughly investigated, will no doubt account for the deviation from the Newtonian law indicated by the preceding comparison, which, let us recollect, is based upon the difference of radiant energy of fused metal at 3,000°, and solid metal at 65°. Considering this extreme range of temperature, and the totally different conditions of the radiators, the observed discrepancy is not too great to admit of satisfactory explanation.

The fallacy of Dulong's formula relating to high temperatures having been conclusively shown, it will not be necessary to examine the calculations of Messrs. M. E. Vicaire and Sainte-Claire Deville, presented to the Academy of Sciences at Paris. Besides, the question of solar temperature cannot be properly investigated without considering the leading points connected with the propagation of radiant heat through space—a subject of too wide a range to be discussed in this article. It should, however, be mentioned that the result of the measurement of solar intensity March 7, 1872, before referred to, proves the correctness of our previous demonstrations, showing that the temperature of the surface of the sun is at least 4,036,000 F.

J. ERICSSON

THE CYCLONE IN THE WEST INDIES

A CORRESPONDENT in your number of October 12, 1871, expresses a wish for an article to appear in your paper, on the Cyclone which passed over Antigua, and several other of the Leeward Islands in the West

Indies, on the 21st of August last. If no other better qualified person has complied with that wish, I beg leave to tender the following account.

Perhaps a few preliminary observations in reference to the working of the barometer in these parts of the Tropics are necessary. A well-regulated mercurial barometer, at or about the sea level, under all ordinary conditions of the atmosphere, with the trades blowing from the east, stands at 30·00 or 30·10. A south-east wind, and the approach of heavy rains, will cause the barometer to fall, at times, to 29·80. At other times a N.E. trade wind, if not a storm wind—though it may bring occasional heavy showers—will cause the barometer to rise to 30·30. Thus the range of the mercury in these islands, when no cyclone is passing, is limited to five-tenths of an inch; but the variation seldom exceeds three-tenths. The atmospheric tide (if I may so call it), which causes the barometer to rise and fall half-a-tenth twice in the twenty-four hours, is very distinctly marked in these islands. The barometer being the highest at 10 A.M. and 10 P.M., and the lowest at 4 A.M. and 4 P.M. Any variation from this rule during the hurricane season calls for vigilance.

The following observations of the movements of the barometer during the late cyclone were taken at an elevation of about twenty-five feet above the sea-level.

The hurricane season of this year was preceded by a long dry season, and though the months of June and July were very hot, and sometimes oppressive, we had very little thunder and lightning. During the month of July we had some very squally weather, but the barometer was not much influenced by it. During the latter part of July and the first weeks of August, the wind often shifted towards the north, which is quite unusual at that time of the year, the barometer at the same time falling below 30·00. These indications caused some anxiety in the minds of those who were accustomed to observe the state of the weather.

The first indications of the approaching storm were noticed at 10 o'clock on the morning of the 20th. A light, but unsteady, wind was blowing at the time from E.N.E., the barometer had not risen after 4 A.M. as usual, and though standing at 30·00, the surface of the mercury was concave, indicating a fall. During the day the wind continued to blow moderately, but in gusts; the barometer slowly falling. Between 4 and 5 o'clock P.M. there was a heavy squall of wind and rain from N. by E., followed by a comparative calm. The appearance of the sky at sunset was most remarkable and alarming to those who understood anything of the indications of an approaching storm. A pale, sickly light, of a coppery hue, was spread over every object, and continued some time after sunset; and at the same time there was the appearance of a windgale in the east. At this time I sent a notice of the approaching storm to those living on the North-east coast, a part of the island likely to be very much exposed to its fury. Some persons did the best they could to secure their houses; but because there was no heavy swell in the sea, the fishermen disregarded the warning, and consequently lost their boats.

It is a singular fact, that about 6 P.M. the barometer not only ceased to fall, but a slight rise was perceptible, which at first led to the supposition that the storm might be only passing, and not approaching, the island. This hope was soon dissipated by the increasing force of the gusts of wind, with another squall of wind and rain about 9 P.M. with a falling barometer.

At midnight the barometer had fallen to 29·50, or about half an inch. Between two and three o'clock A.M., the wind shifted more towards the east, blowing with increased violence, breaking off the branches from the trees, and stripping shingles from the houses; but up to this time no great damage had been done. About 3·30 A.M., a singular circumstance occurred—one which I have never witnessed before, though, during a residence of thirty-three years in these islands, I have experienced many cyclones. The barometer ceased to fall for half an hour; the mercury standing firm at 29·30. This, for the time, led to the conclusion, which soon proved to be erroneous, that the centre of the storm was then passing, and that we had experienced the worst of it. At 4 A.M., the barometer again began to fall, at first slowly, and afterwards rapidly, until, at 6·40, it stood at 28·57, having fallen about an inch and a half below its usual height.

As the barometer fell, the gusts of wind became more violent, shaking large and strongly-built houses to their very foundations, tearing off verandahs, spouting, and window-shutters, and, in some instances, carrying them to great distances. Between 5 and 6 A.M. we experienced the full force of this fearful storm, and it was about this time that a large number of houses, both in town and country, with churches, school-rooms, and estate works, were destroyed.

It was soon after 5 A.M. that the writer was able, from a sheltered position, to have a full view of the awful grandeur of the storm. Low, black clouds, like dark ocean billows driven rapidly overhead; the driving rain like sheets of water; the trees whirled round and beaten nearly to the earth, until rooted up or broken off; the constant flashing of intensely red lightning, with the heavy crash of thunder, mingling with the roaring of the wind—altogether, formed a scene grand and terrific in the extreme; but which was well worth the risk to witness.

About 7 A.M. the centre of the storm passed the south of the island; the barometer began to rise, and the wind changed to S.E. and S. The storm had entirely passed over by 10·30 A.M.

The centre of this storm just touched the extreme south of Antigua; passed directly over St. Kitts, where a calm of twenty minutes was experienced, before the wind burst from the opposite quarter; and also over St. Thomas and Tortola. From thence it passed over the southern islands of the Bahama group. After that I have not been able to trace its course.

Antigua was the first island over which the hurricane passed. Being a comparatively level island—all the high land being situated at the extreme south—it suffered the most severely. Nevis and St. Kitts having mountains from 2,000 to 3,000 feet high, which broke the fury of the storm, only suffered severely in certain parts, principally on the north and east coasts. As the destruction caused by this hurricane has been fully detailed by the newspapers, I need not dwell on that subject in the present paper, but will proceed to state some interesting particulars in reference to the movements of this cyclone.

Its course appears to have been nearly from E. by S. to W. by N. As there was no heavy sea on the shores of Antigua, within a few hours of its arrival, it is evident that it originated within 200 or 300 miles of the island, and during the first hours of its existence was by no means a violent storm.

Its progressive movement was also very slow at first. The first circles struck Antigua soon after 4 P.M. on Sunday, but the centre did not pass until 7 A.M. on Monday; whilst the last half of the storm was only three hours in passing over. It is also evident that from 3·30 to 4 A.M., during the time that the barometer ceased to fall, its progressive movement was altogether suspended, though the rotary motion continued.

After 4 A.M. it began to move with great rapidity, and travelled at a speed, which, as far as I know, has not been equalled by any previous hurricane among these islands. The centre of this cyclone passed Antigua at 7 A.M., and arrived at St. Kitts at 9 A.M., having travelled at the speed of thirty miles per hour. In that island the lofty range of mountains not only broke the force of the rotary motion, but also impeded its progress; so that between St. Kitts and St. Thomas, a distance of 160 miles, it travelled at a

speed of a little more than twenty-two miles per hour, the centre arriving at St. Thomas about 4 P.M. on the 21st. What was the speed and force of its rotary motion, I have no means of correctly ascertaining; but there is no doubt that near the centre it very greatly exceeded that of its progressive motion. The diameter of the storm was about eighty miles, the outer circles taking in at the same time Montserrat in the south, and Barbuda in the north; but was not felt beyond those islands. In its progress towards the west and north it may have extended itself, as is frequently the case with these storms.

On the afternoon of September 25, we again had indications of an approaching cyclone, though not so marked and distinct as on the former occasion. The gale set in about 10 P.M., from N. by E., and continued till 10 A.M. on the 26th, the wind changing to N.N.W. and S.W. The centre just touched the north of the island at 4 A.M. on the 26th. The force of the wind was at no time very great, and did not prove destructive on land—though causing much anxiety and alarm during its progress. The barometer did not fall on this occasion more than half-an-inch.

G. W. WESTERBY

Antigua

PROFESSOR S. F. B. MORSE

INTELLIGENCE has already been received in this country of the death of Samuel Finley Breese Morse, the eminent electrician, who died at New York on the 2nd inst. at the age of eighty-one. Prof. Morse was the son of the Rev. Jedediah Morse, well known as a geographer, and was born at Charlestown, Massachusetts, on the 27th of April, 1791. He was educated at Yale College, but, having determined to become a painter, he came to England in 1811, formed a friendship with Leslie, and in 1813 exhibited at the Royal Academy a colossal picture of "The Dying Hercules." He returned to America, and for a few years followed the profession of a portrait painter. In 1829 he again visited England, and on his return voyage was accompanied by Prof. Jackson, the eminent American chemist and geologist, through whose influence he turned his attention to the conduction of electricity through metallic wire, a subject in which the chemical tastes displayed by him while at College gave him additional interest, and to which he now devoted the whole powers of his mind.

Between 1835 and 1837 Prof. Morse invented several machines which more or less foreshadowed the electric telegraph; and obtained from Congress a vote of 30,000 dollars, with which to make an experimental essay between Washington and Baltimore. The first electric telegraph completed in the United States was the line between these cities, which was finished in 1844. Since that time the Recording Electric Telegraph of Morse has been adopted over the whole country, and at the time of his death there were not less than twenty thousand miles of electric wires, stretching over the States between the Atlantic and the Pacific Ocean.

Prof. Morse received during his life recognition of his services to science from a large number of foreign Governments and scientific societies, not the least remarkable being the one inspired by the late Emperor of the French. At his suggestion delegates from France, Russia, Sweden, Belgium, Holland, Austria, Sardinia, Tuscany, the Holy See, and Turkey, met at Paris, and voted an award of 400,000 frs. to Prof. Morse as a testimonial of appreciation of his services.

A record of Prof. Morse's scientific career would not, however, be complete, without referring to a controversy which some years ago occupied the attention of the scientific world in the United States, in which he was engaged with Prof. Henry, now President of the Smithsonian Institution at Washington. So much personal matter was introduced into the dispute that a special committee of the Board of Regents of the Smithsonian Institution was appointed to investigate the matter, the report of which now lies before us. The result of this investigation is summed up as follows:—

"We have shown that Mr. Morse himself has acknowledged the value of the discoveries of Prof. Henry to his electric telegraph: that his associate and scientific assistant, Dr. Gale, has distinctly affirmed that these discoveries were applied to his telegraph, and that previous to such application it was impossible for Mr. Morse to operate his instrument at a distance; that Prof. Henry's experiments were witnessed by Prof. Hall and others in 1832, and that these experiments showed the possibility of transmitting to a distance a force capable of producing mechanical effects adequate to making telegraphic signals; that Mr. Henry's deposition of 1849 . . . . is strictly correct in all the historical details, and that, so far as it relates to Mr. Henry's own claim as a discoverer, is within what he might have claimed with entire justice; that he gave the deposition reluctantly, and in no spirit of hostility to Mr. Morse; that on that and other occasions he fully admitted the merit of Mr. Morse as an inventor; and that Mr. Morse's patent was extended through the influence of the favourable opinion expressed by Prof. Henry."

The conclusion therefore which must be arrived at, and it is one of no small importance in the history of electrical and telegraphic science, is that to Prof. Henry, and not to Prof. Morse, is unquestionably due the honour of the discovery of a principle which proves the practicability of exciting magnetism through a long coil, or at a distance, either to deflect a needle or to magnetise soft iron.

Prof. Morse's services to science as a successful applier of this principle in its practical details are so unquestionable, that we feel we are but doing a duty in setting this question right on this side the Atlantic.

NOTES

THE following are the names of the candidates who have been selected by the Council of the Royal Society for admission into that body at the forthcoming annual election:—Surgeon-Major Andrew Leith Adams, Prof. W. G. Adams, F. Le Gros Clarke, M.R.C.S., Prof. John Cleland, M.D., Dr. M. Foster, Dr. Wilson Fox, Dr. Arthur Gamgee, Rev. Thomas Hincks, Prof. W. Stanley Jevons, Prof. T. Rupert Jones, Dr. George Johnson, Major T. G. Montgomerie, R.E., Dr. E. L. Ormerod, E. J. Routh, and Dr. W. J. Russell.

AT the meeting of the Royal Geographical Society, held on Monday evening last, a letter was read addressed to the President by Dr. Kirk, H.B.M. consul at Zanzibar, in which that gentleman expressed himself very hopefully of Dr. Livingstone's safety. He thinks there is nothing discouraging in the last news received of him, and that we cannot expect to hear again unti the war at Unyanyembe is closed.

H.R.H. THE DUKE OF EDINBURGH will hold a reception on Saturday evening next in the Picture Galleries of the International Exhibition and in the Royal Albert Hall, on behalf of the Prince of Wales and the Royal Commissioners.

WE understand that Lieut-Colonel Strange, F.R.S., will exhibit at the ordinary meeting of the Royal Society on Thursday, May 2nd, the Great Theodolite designed by him for the Great Indian Trigonometrical Survey of India, and will read a paper descriptive of it.

THE electors of the Waynflete Professorship in Chemistry at Oxford have given notice that it is their intention to proceed to the election of a Professor some time in Act term next. The endowment assigned to the Professorship is 600*l.* per annum,

payable out of the revenues of Magdalen College. The residence required by the College ordinance is six calendar months, at least, between the 10th day of October in every year and the first day of the next ensuing July. By the same ordinance the College may require certain services from the Professor; but the functions and duties of the office are mainly regulated by a statute of the University, the provisions of which, as well as of the College ordinance, may be obtained from the President of Magdalen, to whom persons intending to become candidates are requested to send in their names, and any papers which they may wish to present to the electors in support of their application, on or before the 18th of May.

THE next triennial prize of 300*l.* under the will of the late Sir Astley T. Cooper, Bart. will be awarded to the author of the best essay or treatise on "Injuries and Diseases of the Spinal Cord." The essays or treatises shall contain original experiments and observations, which shall not have been previously published, and each essay or treatise shall be illustrated by preparations, and by drawings, which shall be added to the Museum of Guy's Hospital, and shall, together with the work itself, become henceforth the property of the Institution. Essays must be sent in to Guy's Hospital on or before January 1, 1874. If written in a foreign language they must be accompanied by an English translation.

RADCLIFFE Studentships for persons studying medicine, and desirous of making use of the museum and lectures at Oxford, have been awarded to Mr. Francis T. Carey, of Guy's Hospital, and Mr. C. R. B. Keetley, of St. Bartholomew's Hospital, on the recommendation of Sir James Paget, Sir William Gull, and Dr. John Ogle; and to Mr. Farington M. Granger, of the Hospital of Leeds, on the recommendation of T. P. Teal, M.A., M.B.

M. STEWART of Rossall School has been elected to the Exhibition of 50*l.*, at St. John's College, Cambridge, tenable for three years, for Natural Science. The examiners also honourably mentioned Anderson, of Rugby School, and King's College, London. There were seven candidates. The examiners were —Chemistry, Mr. Main; Physics, Mr. A. Freeman; Physiology, Dr. Bradbury; Geology, Mr. Bonney; Botany, Mr. Hiern.

CAPTAIN G. S. NARES will, on his arrival in England from the Mediterranean, commission the unarmoured screw corvette *Challenger* for special exploring and surveying duties in the Pacific. The *Challenger* is a vessel of 2,306 (1472) tons and 1509 (400) horse power.

IT is proposed, according to the *American Naturalist*, to add a department of Science to the executive branch of the United States Government. It is to be composed of the Storm Signal Corps of the army, the Lighthouse Board, and the Coast Survey Bureau of the Treasury, and the Hydrographic Bureau of the Navy.

WE hear that a proposition is on foot to establish an Agricultural-Meteorological station at Montrouge, near Paris, under the superintendence of M. Ch. Moureaux.

A COMMUINCATION to the Corporation of Brown University, in America, was recently presented from Colonel Stephen T. Olney, making a munificent offer of his herbarium and books on botany, on condition that a suitable building should be provided for their reception. It was referred to a committee.

THE officers of the Boston (U.S.) Young Men's Christian Union, recognising the importance of scientific studies and the need of encouraging scientific tastes, have determined to establish in the rooms of the Union a natural history cabinet. Their object in providing such a collection is to foster the growing taste for science among the young men of Boston, and to open a new source of instruction and amusement to the members of the Union.

A VERY interesting collection of water-colour drawings made by Mr. W. Simpson, on the various excavations below the modern city of Jerusalem, which have been carried on for the past three years by the Palestine exploration, under the superintendence of Captain Warren, of the Engineers, is now placed for exhibition in the Gallery, 48, Pall Mall. Most of the drawings are taken in the excavations or in the sacred tombs and caves; but the artist has made his series complete by two or three which represent the massive walls of Jerusalem as they are now to be seen above ground, as well as that part of them which has been discovered at the depth of 125 ft.

AT the meeting of the Manchester Literary and Philosophical Society on March 19, the President, Mr. E. W. Binney, read an elaborate paper, entitled "Additional Notes on the Lancashire Drift Deposits."

AT the Annual Meeting of the Bengal Social Science Association, Dr. Ewart, the president, delivered an excellent address on the necessity for the introduction into the schools preparing students for the entrance examination of the University of Calcutta, of the study of the rudimentary principles of the natural and physical sciences. Although the University was avowedly founded on the model of the London University, the traditional policy of the older Universities is apparent in the exclusion of Science; and a movement commenced last year to introduce examination in various branches of science has at present failed. Dr. Ewart points out with great force the injury which the higher education has suffered in England from a similar course, and that the "existing metaphysical system of education is fast flooding the country with a class of gentlemen who cannot find occupation suitable to the kind and nature of the training they have received." "Are we to wait here," he inquires, "simply to follow in the wake of England in this matter? Is India to go through a long embryo state of preparation like the Western nations, extending over many centuries?"

A NEW technical paper has been started at Brussels, entitled *Chronique de l'Industrie*, answering to our English papers, the *Engineer* and *Engineering*.

DR. L. PFEIFFER, of Cassel, has published the two first parts of a work which will be indispensable to every systematic botanist, "Nomenclator Botanicus," being an alphabetical enumeration of the names of all classes, orders, tribes, families, divisions, genera, sub-genera, and sections of plants, published down to the end of the year 1858, with copious references to the authorities, systematic arrangement, synonymy, and first publication. From the care evidenced in the parts already published, the work will supply a desideratum long felt in botanical literature; and the author, who is an amateur man of science holding no official position, deserves the thanks of all botanists. Arrangements are made by which the work may be carried down to the present time.

MR. C. P. HOBKIRK, of Huddersfield, announces as in course of preparation, A Synopsis of the British Mosses, in 1 vol. 8vo.

THE long-expected translation of Le Maôut and Decaisne's "Traité Général de Botanique," by Mrs. J. D. Hooker, is announced by Messrs. Longman as in the press.

MESSRS. BRADBURY AND EVANS have in the press "Botany for Beginners," by Dr. Maxwell T. Masters, F.R.S., a portion of which has already appeared in the columns of the *Gardener's Chronicle*.

A VERY interesting series of articles on the animals contained in the Crystal Palace Aquarium, by Mr. Edward Newman, F.L.S., is now being published in *The Field*.

THE Catalogue of Microscopical Preparations in the Quekett Microscopical Club, consisting of about 2,000 slides, is chiefly

of interest from the plan on which they are classified. The arranging and cataloguing a large collection of microscopical preparations in a satisfactory manner is admitted to be a work of considerable difficulty. In the present instance the catalogue is divided into five groups, containing Vertebrata, Invertebrata, Phanerogamia, Cryptogamia, and Mineral Substances. Each of the groups Vertebrata and Invertebrata is again subdivided into orders; and the Phanerogamia into stems, fibres, cell structure, cuticles, hairs, pollen, seeds, and starches. The Cryptogamia are subdivided into ferns, mosses, fungi, characeæ, algæ, desmids, and diatoms. The minerals are without subdivision. Although this classification is open to some objections, yet, on the whole, it was perhaps about the best which could have been done with the materials; and the catalogue, which is on sale for the benefit of microscopists generally, will furnish a long list of objects for those who are collecting. In some of the subsections —as, for instance, the hairs of bats, fructification of ferns, and microscopic seeds—the cabinet appears to be remarkably complete. Indeed, it is doubtful whether these sections can be equalled in the cabinet of any other society.

IN a letter to the Minister of Foreign Affairs, brought before the French Academy on February 26, a report is given of the earthquake shock felt at Malaga on January 28 at $3^h\ 1^m$ P.M. The undulatory movement lasted from four to six seconds, and subterranean noises were heard previously to the shock. The direction was from north to south. No damage is reported.

THE *American Journal of Science* gives an account of the earthquake of the 9th of January experienced in New England. It occurred over a considerable portion of Eastern New England and the St. Lawrence Valley, at a few moments before 8 P.M. on January 9. It was felt along the St. Lawrence River to a distance of 200 miles north-east and 60 miles south-west from Quebec, and at various points of New Hampshire and Maine. The disturbance was greatest at Quebec, where some walls were cracked, and large fissures caused in the ice bridge over the river. The shock occurred there at 7·54 P.M. and lasted about thirty seconds, being accompanied by a low rumbling sound. At Lancaster, in New Hampshire, there were two distinct shocks, each lasting but a few seconds, the last being the most violent. The direction of vibrations was well defined, and approximately west to east. Probably the true direction was from a point somewhat south of west, which would coincide nearly with the course of the St. Lawrence River, and with the shorter diameter of the region shaken. At Quebec and Bangor slight shocks were felt at 3 P.M. and 11 P.M. on the same day.

THE towns of Dresden, Perna, Schandau, Chemnitz, Bodenbach, Wurmar, and Rudolstadt, were visited almost simultaneously by a succession of earthquake shocks between three and four o'clock on Wednesday, March 6. They continued to recur during an hour, and in some instances during several hours. Little damage was done.

A CORRESPONDENT of the *Times*, telegraphing from Alexandretta, states that half the town of Antioch was destroyed by an earthquake on April 3. Fifteen hundred persons were killed. Great distress prevails in consequence. The shock was also felt at Aleppo, but without any damage being done.

WE have received the second part of the Proceedings of the Bristol Naturalists' Society for 1871. Like other similar publications which we have had occasion to notice recently, it contains no original articles bearing on the natural history of the district, or containing original observations. The proceedings of the Sections are also rather scant, though they bear evidence of some work having been done in Geology and Entomology.

WE have received a series of chemical labels published by Messrs. Mottershead and Co., of Manchester. The labels are printed in good legible type, better than is usual in such cases, the backs being gummed ready for use. No definite system of chemical nomenclature has been used, in many instances the common or old names of the reagents are given, although perhaps in some cases to the sacrifice of scientific accuracy. Contrary to the usual practice, no symbols are attached, the publishers preferring to leave space for the insertion of these, according to the views held by each chemist. At the end of the reagents a number of slips are attached, with the words "pure," "commercial," &c., to qualify the foregoing labels. The total number given is considerable, forming a very good and cheap series (*9d.*)

OBSERVATIONS OF THE AURORA BOREALIS OF FEBRUARY 4 *&* 5, 1872 *

THE splendid aurora by which our sky was illuminated yesterday evening was remarkable for the great variety of appearances which it displayed, for its intensity, its duration, and lastly for the large expanse of sky over which it spread. In fact it exhibited collectively all the principal phenomena observed in former appearances of this meteor: that is to say, luminous arches of various colours, dark arches, moveable clouds of red and green colour, bright rays both isolated and united in large bundles, dark rays, diverging and converging rays, red pillars, changes of colour, &c., &c. It lasted from about six o'clock till after midnight, whereas in most cases the duration of the phenomenon does not exceed a few hours, and is not unfrequently less than an hour. The auroral light, under various forms and colours, extended over nearly the whole of the sky, whereas it is usually limited to the northern region.

The want of magnetic instruments prevented me from foreseeing by their perturbations the approach of the phenomenon, so that I did not perceive it till about 6h. 30m., by which time it was already developed in vast proportions. I arrived, however, in time to observe all the principal phases, and to analyse the various coloured lights with the spectroscope.

Although the numerous phenomena observed in this aurora did not present anything actually new, still their detailed description will be of great advantage to science, as exhibiting the order of their succession and their mutual relations and dependences. Such scope, however, could be attained only by a long and systematic description; and for the present I must limit myself to an account of my spectroscopic observations.

The greenish yellow light which illuminated certain arches and isolated clouds, and likewise the part of the sky near the magnetic meridian, appeared, when examined by the spectroscope, to be monochromatic, its spectrum being almost wholly concentrated in a beautiful green line, the position of which was very near the division 1241 of Kirchhoff's scale.

In the brightest parts nearest to the magnetic meridian, and in a few yellow rays near the zenith, I discovered, by means of the spectroscope, a second green line situated towards the blue, and corresponding very nearly with the division 1820 of Kirchhoff's scale. The line 1241 is near a known line of iron, and 1820 is near a known line of atmospheric air.

The second green line was very much less bright than the first, but nevertheless very distinct. Between these two lines were traces of several other faint lines, the position of which I was unable to determine.

On the decidedly red mass I could not make out any distinct bright line, but only certain bands of continuous spectrum. On the yellow-red mass I detected the bright line 1241, without any distinct lines in the red.

The spectroscopic observations were continued with the same results till about the middle of the night, when the aurora had almost entirely vanished.

The atmospheric conditions during the phenomenon were normal, only a few masses of cloud being seen from time to time near the horizon; and I observed an appearance which seemed to me especially worthy of notice—namely, a continuous glow proceeding from the horizon towards the S.S.E., by which some clouds and a stratum of mist were lighted up almost continuously

* Translated from the *Gazetta Ufficiale del Regno d'Italia*, Feb. 6.

and with considerable brightness, chiefly from half-past eight to ten o'clock.

During the phenomenon several falling stars were observed, and a magnificent bolide in the Great Bear at 8h. 30m., but this was probably accidental.

This evening, in the expectation that the aurora borealis might reappear, I began to observe the sky as soon as twilight was over, and I perceived a faint glow, a kind of phosphorescence, diffused over the whole sky, but without any decided appearance of boreal light.

While waiting for more imposing phenomena, I directed the spectroscope towards the zodiacal light, to ascertain whether its spectrum could be observed at Rome, as it had been observed on the Red Sea on the evening of the 11th, and the morning of the 12th January last.

Angström, in 1867, found the spectrum of the zodiacal light to be monochromatic, consisting of a single green line, to which he assigned approximately the position 1259 on Kirchhoff's scale, the same that he had determined for the green line of the aurora borealis; and I myself, on the days above mentioned, was able to perceive in the zodiacal light, not only this green line, but near it and towards the blue, a band or zone of apparently continuous spectrum.

This evening at seven o'clock, I was able to discern the same spectrum in the light above mentioned; and on directing the spectroscope to other points, I found that this spectrum showed itself in all parts of the heavens from the horizon to the zenith, more or less defined in different parts, but everywhere as bright as in the zodiacal light. The observatory assistant, Dr. di Legge, likewise observed this spectrum distinctly, in various parts of the heavens.

This fact, which corroborates an analogous observation made by Angström in 1867, appears to me of the greatest importance, inasmuch as it demonstrates the identity of the zodiacal light with that of the aurora, and thereby tends to establish the identity of their origin, and to unite into one these two mysterious phenomena.

L. RESPIGHI

Observatory of the Royal University of Campidoglio,
Feb. 5, 1872.

PHYSIOLOGY

Note on Recurrent Vision*

IN the course of some experiments with a new double plate Holtz machine, belonging to the college, I have come upon a very curious phenomenon, which I do not remember ever to have seen noticed. The machine gives easily intense Leyden jar sparks from seven to nine inches in length, and of most dazzling brilliance. When, in a darkened room, the eye is screened from the direct light of the spark, the illumination produced is sufficient to render everything in the apartment perfectly visible; and what is remarkable, every conspicuous object is seen *twice* at least, with an interval of a trifle less than one quarter of a second—the first time vividly, the second time faintly; often it is seen a third, and sometimes, but only with great difficulty, even a fourth time. The appearance is precisely as if the object had been suddenly illuminated by a light at first bright, but rapidly fading to extinction, and as if, while the illumination lasted, the observer were winking as fast as possible.

I see it best by setting up in front of the machine, at a distance of eight or ten feet, a white screen having upon it a black cross, with arms about three feet long and one foot wide, made of strips of cambric. That the phenomenon is really subjective, and not due to a succession of sparks, is easily shown by swinging the screen from side to side. The black cross, at all the periods of visibility, occupies the same place, and is apparently stationary. The same is true of a stroboscopic disc in rapid revolution; it is seen several times by each spark, but each time in the same position. There is no apparent multiplication of a moving object of any sort.

The interval between the successive instants of visibility was measured roughly as follows:—A tuning fork, making 92½ vibrations per second, was adjusted, so as to record its motion upon the smoked surface of a revolving cylinder, and an electromagnet was so arranged as to record any motion of its armature upon the trace of the fork: a key connected with this magnet was in the hands of the observer. An assistant turned the machine slowly, so as to produce a spark once in two or three seconds, while the observer manipulated the key.

In my own case the mean of a dozen experiments gave $0^s{\cdot}22$ as the interval between the first and second seeing of the cross upon the screen; separate results varying from $0^s{\cdot}17$ to $0^s{\cdot}30$. Another observer found $0^s{\cdot}24$ as a result of a similar series.

Whatever the true explanation may turn out to be, the phenomenon at least suggests the idea of a *reflection of the nervous impulse* at the nerve extremities—as if the intense impression upon the retina, after being the first time propagated to the brain, were there reflected, returned to the retina, and from the retina travelling again to the brain renewed the sensation. I have ventured to call the phenomenon "Recurrent vision."

It may be seen, with some difficulty, by the help of an induction coil and Leyden jar; or even by simply charging a Leyden jar with an old-fashioned electrical machine, and discharging it in a darkened room. The spark must be, at least, an inch in length.

Hanover, February 9

* From the *American Journal of Science and Art* for April. By Prof. C. A. Young, of Dartmouth College.

SCIENTIFIC SERIALS

Annales de Chimie et de Physique, July and August, 1871. This number contains the second portion of a very lengthy memoir by M. Berthelot on explosive agents in general; this half of the communication deals with dynamite, gun cotton, picric acid and potassic picrate. At the end of the memoir a general table is given which shows the amount of heat generated and the volume of gas formed by one kilogram of substance; the product of these two numbers will of course give the relative effects produced by each compound; the numbers given show that if nitroglycerine produces an amount of force equal to 94, picric acid equals 54, gun cotton 50, potassic picrate 34, whilst gunpowder has only an explosive force equal to 14. M. Janssen contributes a very valuable paper on the atmospheric lines in the solar spectrum. He finds that the bands observed by Brewster and Gladstone can be resolved into fine lines comparable to the solar lines properly so called, and that the atmospheric lines are more numerous than the solar lines in the red, orange, and yellow portions of the spectrum. The atmospheric lines are always visible in the solar spectrum, some lines it is true almost disappear when the sun is very high, but they are those which are never very intense; the author finds that the intensity of the atmospheric lines observed at the horizon is about fifteen times as great as when observed in the meridian. M. Janssen has also examined the spectrum of the moon and stars, and more particularly of Sirius and α in Orion; he has not succeeded in observing any new lines whatever in the spectrum of the moon, proving that our satellite cannot have any appreciable atmosphere. M. Raoult has found that a solution of cane sugar sealed up in vacuo and exposed to light for five months is partially changed into glucose. Amongst the other original memoirs there is a very long one by Dr. de Coppet on the temperature of congelation in saline solutions. There are also a considerable number of abstracts of papers from foreign journals, making up altogether a very bulky number.

THE *Journal of the Quekett Microscopical Club*, No. 18, April 1872, contains the following three communications:—"Observations on the Polyzoa, by A. H. H. Lattey, M.R.C.P." This paper is chiefly devoted to the preparation of the Polyzoa for the microscope, so as to exhibit them in permanence with the tentacles expanded.—"On the so-called 'nerve' of the Tooth," by T. C. White, Hon. Sec. The principal elements met with in a microscopical examination of what is popularly termed the "nerve" of the tooth, are here indicated, and suggestions are given to assist in the more complete examination of tooth-structure.—"On the Internal Structure of the *Pulex irritans*," by W. H. Furlonge. This is a second communication on the structure of the flea which has been submitted to the club by its author. The first was occupied chiefly in the examination of external organs, the present is devoted to internal structure, commencing with the alimentary and digestive system, then follow remarks on the respiratory system, and finally observations on the reproductive system. The embryology is left untouched, to form the subject of a third and concluding paper, which will then embrace the life history of one of the commonest, but not the least interesting, of British insects. The club announced its list of excursions for the season com-

mencing April 6, and terminating October 5. There are fifteen excursions, of which fourteen are announced for Saturday afternoons, one whole day excursion, and one day excursion ending with the excursionists' annual dinner. The annual *soirée* of the club was held at University College on Friday evening, March 22, and was attended by about 1,200 persons.

Journal of the Chemical Society, February. — Dr. Armstrong contributes a paper "On the nitration products of the dichlorophenolsulphonic acids," being a continuation of his researches published in recent numbers of this journal. The next communication is on Eulyte and Dyslyte, by H. Bassett, being a re-examination of these bodies, which were briefly described by Baup in 1851. The third and last original communication is by Dr. Howard, "On Quinicine and Cinchonicine and their salts." Some time since the author gave an account of an amorphous alkaloid from cinchona bark, the properties of which distinguished it from those already described. Further investigations, however, have shown that it is probably identical with quinicine, first obtained by Pasteur by the action of heat on quinine. The author finds that the quinicine obtained from quinine, and that obtained from quinoidine, are identical in their properties. Several salts of cinchonicine have been prepared; there is considerable resemblance between them and the quinicine salts, although the former are somewhat more soluble. The same identity is observed between the cinchonicines obtained from cinchonine and from cinchonidine as was observed in the case of quinicine. The action of these alkaloids on polarised light confirms the identity already mentioned. Thus, the quinicines prepared, either from quinine (which possesses a strong left-handed rotation), or from quinidine (which has a right-handed rotation), exhibit a feeble right-handed rotation, which, in each case, is almost identical. The abstracts of papers in foreign journals occupy seventy-pages, and, as usual, are of great interest.

Verhandlungen der k. k. geologischen Reichanstalt zu Wien. Nos. 3 and 4. The articles in these numbers are for the most part of local interest; but we notice a short sketch of the geological structure of East Greenland by F. Toula—some of the fruits of the last German expedition—which will be read with interest. Literary and other notices, as usual, occupy considerable space in the proceedings.

THE *Geological Magazine* for April 1872 (No. 94) opens with an excellent article from the pen of Mr. W. Davies, of the British Museum, on the rostral prolongations of the singular Liassic Fish, described by Agassiz under the name of *Squaloraia polyspondyla*. The two projecting processes from the snout of this fish were regarded by Dr. Riley and Prof. Agassiz as forming a single rostrum; but Mr. Davies argues with justice that the upper one is really a cephalic spine analogous to that met with in a similar situation in the male Chimæridæ, and that it was employed, as by them, in conjunction with the elongated rostrum, for securely clasping the female. Mr. Davies refers to other points in the anatomy of this curious fish, which he illustrates with a large plate.—Prof. Dyer commences the description of some remains of coniferous plants from the lithographic stone of Solenhofen; the form here described is named by him *Araucarites Haberleinii*.—From Mr. Searles Wood, jun. we have a paper on the climate of the post-glacial period, and a reply to Mr. James Geikie's Correlation of the Scotch and English Glacial beds, whilst the last-mentioned author contributes a fifth paper on Changes of Climate during the Glacial epoch.—Some points in the Geology of the East Lothian coast, form the subject of a paper by Messrs. G. W. and F. M. Balfour, in which they describe the peculiar relations existing between the porphyrite of Whitberry Point and the adjacent sedimentary (sandstone) rocks, the latter being found to dip on all sides towards the mass of porphyrite. The authors suppose the porphyrite to have been erupted through a small orifice, and to have caused the depression of the sedimentary beds by pressure.

THE original articles in the March number of the *American Naturalist* are not so numerous as usual. Prof. J. D. Biscoe commences with a description of the breathing-pores or stomates of leaves.—Prof. H. W. Parker describes the meteorological phenomena witnessed in the western prairies, including the very common occurrence of parhelia in mock suns.—Dr. R. H. Ward has some remarks on uniformity of nomenclature in regard to microscopical objectives and oculars, of considerable interest to microscopists.—The most important article is "On the Stone Age in New Jersey," by Dr. Chas. C. Abbott, illustrated with a number of woodcuts of the rude implements and utensils found throughout that State, the relics of its original Indian inhabitants.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, April 10.—"Notice of some of the Secondary Effects of the Earthquake of the 10th January, 1869, in Cachar." Communicated by Dr. Oldham, of Calcutta, with remarks by Mr. Robert Mallet, C.E., F.R.S. This earthquake was a severe one, being strongly felt in Calcutta, distant from the meizoseismic area about 200 miles, and far into the plain of Bengal. The effects were examined on the spot a few weeks after the shock by Dr. Oldham, who anticipates being able to fix the position and depth of the centre of impulse by following the same methods as those first employed by Mr. Mallet with respect to the great Neapolitan earthquake of 1857. These results have not yet been received; but Dr. Oldham has forwarded an extremely interesting letter on the circumstances of production of very large earth-fissures, and of the welling up of water from these, derived from the water-bearing ooze-bed, upon which reposed the deep-clay beds in which the fissures were formed. Dr. Oldham rightly views all these fissures, which were all nearly parallel to and not far distant from the steep river banks, as "secondary effects," and not due to fractures produced by the direct passage of the wave of shock. He also shows that the welling up or overflowing of the water in the fissures was a secondary effect also, and negatives the notion entertained on the spot of mud-volcanoes, &c., having originated at those fissures. The chief aim of Mr. Mallet's remarks was to point out the importance to geologists of rightly comprehending the dynamics of production of these phenomena, and to show that the older notions of geologists as to earthquake-fissures are untenable. He explained clearly, aided by diagrams, the train of forces by which the elastic wave of shock, on passing out of the deep-clay beds where these have a *free side* forming the steep river banks, dislodges certain portions and throws them off towards that free side—and that this is but a case of the general law in accordance with which such elastic waves behave towards more or less incoherent deposits reposing on inclined or on level beds, under various conditions. Mr. Mallet also explained the dynamic conditions under which the water from water-bearing beds, such as that of ooze beneath the Cachar clay beds, becomes elevated in the fissures formed, and gave approximate expressions for the minimum height to which the water can rise in relation to the velocity of the elastic wave particle. The paper concluded with some explanatory remarks upon the continual noises, like the irregular fire of distant artillery, heard long after the shock had passed, and when the country had become perfectly quiescent. The noble collection of photographs which were made by Dr. Oldham, and forwarded to Mr. Mallet, illustrative of the physical features of the huge earth-fissures and other effects of this earthquake, were exhibited to the Fellows present, and are well worthy of attentive study. Sir Henry James inquired whether there was any trace of fissuring in the lower beds beneath the slimy ooze. Mr. Scott wished to ascertain the author's opinion as to the possibility of predicting earthquakes on meteorological grounds, as had been done by M. Boulard, several of whose prophecies were said to have been fulfilled. Mr. D. Forbes gave some details of the earthquake of Mendoza, a town situated on a vast alluvial plain at the foot of the Andes, in which the phenomena remarkably coincided with those detailed by Dr. Oldham. In that case he found that the rumours as to fire and smoke having been emitted from fissures were entirely without foundation, the presumed smoke having been nothing but dust. The earthquake was felt over a distance of 1,200 miles; and wherever the firm rock came to the surface there was no trace of fissure, though portions of the rock were overthrown. But in the plain, consisting of 30 or 40 feet of alluvial soil, the whole ground was in places fissured, and in some districts the surface completely furrowed, and even the turf turned over. He had witnessed numerous earthquakes, and in some cases had been in deep mines during their occurrence, when the sound only could be heard, and he could testify to their effects being confined to the surface. The direction of the fissures was invariably at right angles to the line of shock. In South America all the earth-

quakes could be traced to volcanic centres. The President inquired as to the distinction to be drawn between the primary and secondary effects of earthquakes, and whether the author thought that no fissures were attributable to the direct action of earthquakes. As to the cause of the sound, like that of a cart carrying iron bars or of an artillery waggon, he wished for further information. Mr. Mallet, in reply, explained that fissures only take place where masses were comparatively free in one direction. They might extend to enormous depths, though they often closed in rapidly. With regard to the power of predicting earthquakes, he disbelieved in it wholly, and considered that any fulfilment of such prophecies must be due to accident; earthquakes are so numerous, that the chances of such fulfilments are great. The blow or impulse originating earthquakes could not be attributed solely to one cause. It arose often from deep subterranean volcanic action; but it also—especially in the case of long-continued tremors, like those of Comrie or Pignerol—arose from the breaking up or the grinding over each other of rocky beds at a great depth, through the tangential pressures produced in the earth's crust by secular cooling. The arrested impulse of the fall of the Rosberg in Switzerland produced a sensible earthquake. Fissures in hard rock could not be produced *directly* by the shock, because the velocity of impulse in such rock greatly exceeded that of the elastic wave particle. The earth's crust was at present not in a state of tension, but of compression, through secular cooling.

Zoological Society, April 16.—Dr. E. Hamilton, vice-president, in the chair. A letter was read from Dr. R. Schomburgh, of the Botanic Gardens, Adelaide, South Australia, containing an account of the apparently reasonable conduct of a monkey kept in the gardens.—Mr. A. H. Garrod, Prosector to the Society, read a paper on the mechanism of the gizzard in birds, in which he endeavoured to show that the ordinary action of this organ was that of compression, and not of trituration as usually understood.—A communication was read from Dr. John Anderson, on a supposed new monkey from the Sunderbunds to the east of Calcutta, allied to *Maccacus rhesus*.—A communication was read from Mr. W. H. Hudson, containing remarks on the birds of the Rio Negro of Patagonia, as observed during a recent visit to that locality. To this was added an appendix, by Mr. Sclater, giving a scientific account of Mr. Hudson's collections.—A communication was read from Mr. R. Swinhoe, containing descriptions of two new pheasants (*Phasianus ellioti* and *Pucrasia darwini*) and a new *Garrulax* (*G. picticollis*) from the vicinity of Ningpo, China.—A paper by Mr. F. Moore was read containing the descriptions of a large number of new species of Indian Lepidoptera.—Mr. E. W. H. Holdsworth read notes on a Cetacean observed on the west coast of Ceylon, remarkable for possessing a long, straight dorsal fin, and known to the natives as the "Palmyra fish."—Dr. A. Günther read a paper on a collection of reptiles and amphibians made at Metang, in the district of Sarawak, Borneo; to which was added a synopsis of the known species of these classes hitherto recorded from that island. These were stated to be altogether 153 in number.—Sir Victor Brooke, Bart., gave a description of a supposed new species of gazelle from Ugogo in Eastern Africa, which he proposed to designate *Gazella granti*.

Linnean Society, April 18.—Mr. G. Bentham, president, in the chair. Mr. M. E. Grant-Duff, M.P., was elected a fellow.—The President announced the death of Prof. v. Mohl, one of the foreign members of the society.—Prof. Oliver described four new genera of plants recently received at the Kew Herbarium. 1. A new genus of Begoniaceæ, from New Grenada, of special interest, as the order at present consists only of the large genus *Begonia*, and another monotypic one from the Sandwich Isles. It resembles in habit the series of *Begonia* with thin membranous leaves not cordate at the base; but is very aberrant from the typical genus in possessing a single monophyllous perianth, and being monœcious, the male flowers possessing only four stamens, which are apparently didynamous, and give the plant an external resemblance to Gesneraceæ, the ovary, however, is that of typical *Begonia*. Prof. Oliver gives this new genus the name *Begoniella*. It does not appear to throw any light on the difficult affinities of the order. The three other genera are from Dr. Maingay's collection from the Malay Peninsula. The first is a new genus of Hamamelidæ, *Maingaya*, in which the calyx is perfectly closed in the bud, and afterwards ruptured. The order is of interest as going back at least to the Miocene period, and still existing in both hemispheres. The two other new genera belong to the order Olacineæ. The first, *Ctenolophon*, is one of the few genera of the order with opposite leaves. The second, *Pteleocarpa*, includes two species from Malacca and Borneo.—Prof. Thiselton Dyer on the Assam tea-plant. The Chinese tea-plant is not known in the wild state. The Assam tea-plant may be its indigenous form, but presents well-marked differences.—Dr. Braithwaite on *Zoopsis*, Hook. and Tayl., a genus of Hepaticeæ.

Chemical Society, April 18.—The president, Dr. Frankland, F.R.S., in the chair.—The secretary read two papers by Mr. E. A. Letts, "On benzyl isocyanate and cyanurate," and "On a compound of sodium and glycerine."—Prof. Hunly, of Kiel, who spoke in German, gave an account of a new method of determining the carbonic acid in sea-water, and of an apparatus for collecting the water at great depths, which could be immersed to the required distance below the surface, and then closed by means of stop-cocks. These are turned by powerful springs released at the proper moment by an electro-magnet.—Dr. E. T. Thorpe followed with notes on the action of phosphorus pentasulphide on tetrachloride of carbon, and on the degree of solubility of silver chloride in strong nitric acid.—Dr. Hofmann, F.R.S., then gave a brief account of the new phosphorus bases, which he had recently obtained by the action of alcoholic iodides on iodide of phosphonium on the presence of zinc oxide, and illustrated his remarks by several striking experiments.

Mathematical Society, April 11.—Prof. Cayley, F.R.S., vice-president, in the chair.—Prof. Cayley gave an account of a paper "On the Mechanical Description of certain Sextic Curves."—Mr. Roberts then exhibited an apparatus for the description of such curves as had been alluded to by Prof. Cayley; and further drew attention to an analogous manner in which certain surfaces of the fourth degree may be generated.—A discussion followed upon some questions proposed in which the chairman, Prof. Crofton, Messrs. Cotterill, Merrifield, Sprague, and others took part.

Photographic Society, April 9.—James Glaisher, F.R.S., in the chair. A paper on Merget's Mercury-Printing Process was read, and some photographs produced by its means were shown. The photographic image is produced by the reduction of silver, or other precious metal, salts, by mercuric vapour, which has been in the first place collected upon a cliché obtained in the camera. The process is not yet sufficiently elaborated to be of much practical value.—A paper "On the Photographic Image upon a Bichromate Film" was read by Mr. H. Baden Pritchard, who demonstrated by a few examples the rapidity with which the image, once started by light upon a carbon tissue, continues to acquire vigour after the latter has been withdrawn from the action of the solar rays.

Victoria Institute, April 15.—The Rev. J. G. Wood "On the Rationality of the Lower Animals." He gave various instances of the instinct and rationality of different animals inhabiting various portions of the globe, and dwelt principally on the latter, which he considered many animals to possess, though in a very limited sense. An interesting discussion followed, in which Captain Petrie pointed out that had the animal creation no rationality, or rather intelligence, it would be without an attribute, which helped to make it more subservient to man's wants. The Rev. C. A. Roe pointed out that the reasoning powers of man were different from the reason possessed by animals, which was exceedingly limited, and of a peculiar nature.

MANCHESTER

Literary and Philosophical Society, March 5.—E. W. Binney, F.R.S., president, in the chair. "On Changes in the Distribution of Barometric Pressure, Temperature, and Rainfall under different Winds during a Solar Spot Period," by Joseph Baxendell, F.R.A.S.—"Further Experiments on the Rupture of Iron Wire," by Mr. John Hopkinson.

Physical and Mathematical Section, November 7, 1871.—Alfred Brothers, F.R.A.S., vice-president, in the chair. "On Changes in the Distribution of Barometric Pressure, Temperature, and Rainfall, under different winds, during a Solar Spot Period," by Joseph Baxendell, F.R.A.S.

December 5, 1871.—Mr. Thomas Carrick in the chair. "On the Distribution of Rainfall under different Winds, at St. Petersburg, during a Solar Spot Period," by Joseph Baxendell, F.R.A.S.

February 27.—E. W. Binney, F.R.S., vice-president of the section, in the chair. "Results of Observations, registered at

Eccles, on the Direction and Range of the Wind for 1869, as made by an Automatic Anemometer for Pressure and Direction," by Thomas Mackereth, F.R.A.S.—"On Black Bulb Solar Radiation Thermometers exposed in various Media," by G. V. Vernon, F.R.A.S.—Note "On the Relative Velocities of different Winds, at Southport, and Eccles, near Manchester," by Joseph Baxendell, F.R.A.S.

CAMBRIDGE

Philosophical Society, March 11.—Mr. E. H. Morgan, of Jesus College, and Mr. J. W. Cartmell, of Christ's College, were elected fellows. The following communications were read:—(1) By Mr. Hiern, "A monograph of the *Ebenaceæ*." This elaborate paper will shortly appear in the Society's Transactions. (2) By Dr. Bacon, "The influence of human generations on the production of insanity." The author brought forward statistics to prove that insanity was proportionate to poverty—the greatest number of insane persons being found in the poorest districts. Hence he considered that ameliorating the condition of the people was of the first importance in the attack on this disease. (3) By Mr. J. W. L. Glaisher, "Supplement to a table of Bernouilli's numbers."

EDINBURGH

Royal Society, March 18.—Sir Robert Christison, Bart., president, in the chair.—"On the Extraction of a Square Root of a Matrix of the Third Order," by Prof. Cayley.—"Second Note on the Strain-Function," by Prof. Tait.—"Note on the Rate of Cooling at High Temperatures," by Prof. Tait.—"Notice of a Whinstone Boulder with Artificial Markings and Grooves on it," by Mr. D. Milne Home, LL.D.—"Notice of the Fruiting of the Ipecacuan Plant in the Edinburgh Royal Botanic Garden," by Prof. Balfour.

Royal Physical Society, March 27.—Mr. C. W. Peach, president, in the chair. Note on the occurrence of the Hoopoe (*Upupa Epops*) at Freugh, Stoneykirk, Wigtownshire, by Rev. George Wilson. The specimen, a male in perfect plumage, was shot by Mr. Cunningham on March 16.—Notice of a species of Mason Ant on the Isle of Man, by James M'Bain, M.D. Dr. M'Bain visited the Isle of Man on Feb. 16, and obtained specimens of the ants, with eggs, larvæ, and attendant aphides. The ants since then had been kept in glass vessels, and one of the artificial Formicarias was exhibited to the Royal Physical Society. There appeared to be two species of ants in the colonies, one of which corresponded with the specific characters of the yellow ant, *Formica flava*, and, being in doubt as to the specific name of the brown ant, specimens of each were sent to the British Museum. Mr. F. Smith, a distinguished authority on the *Hymenoptera*, stated that "there are two species and two genera in the quill—one is *Formica flava*, the other is *Myrmica ruginodes*. The Formica is at once known by its single lamina, node (or scale) between thorax and abdomen; the Myrmica has two nodes, and also a sting. These ants commonly occupy opposite sides of the same hillock."—"On the Vegetable and Animal Life found in Natural Waters," by Dr. Stevenson Macadam.—Notes of a Tour in Auvergne, with an exposition of some of the most illustrative minerals of Central France; and remarks on the nidification of some species of the family *Mytilidæ*, by Mr. D. Grieve.—Analysis of "The Albert Limestone," Balmoral, by Mr. J. Falconer King.—Prof. Walley exhibited a curious example of malformation in a newly-born calf. The upper part of the skull was undeveloped, it had no apparent forelegs, only rudimentary and imperfect hindlegs, a rudimentary tail, and was otherwise imperfectly developed.

GLASGOW

Geological Society, March 21.—Mr. James Thomson, vice-president, in the chair.—"Some Recently-exposed Sections in the Paisley Clay-beds, and their Relation to the Glacial Period," by the Rev. William Fraser, of Paisley. These clays presented the following general order:—(1) Underlying all was the old boulder clay or till, the conditions of which were altogether unfavourable to life. It represented a cold, bleak, and in part tumultuary period. (2.) Immediately above this was a laminated clay, whose texture was in every way distinct from the preceding. It was generally shell-less and stoneless and beautifully laminated, the structure being at times so regular as to resemble the edge of a closed book, and specimens kept for a year or two have shown a texture and taken a polish like jasper. (3) Above the laminated clay, which was useful in brickmaking, there occurs a thick bed in which shells of arctic and boreal types are found—*Tellina proxima*, *Panopæa norvegica*, *Pecten islandicus*, *Cyprina islandica*, and others too numerous to specify. Geologists loved the layer for its shells, which the brick-field proprietors regarded with an intense dislike. (4.) Next in order is the clay chiefly used in brickmaking. In it the glacial shells are not to be found; the last which disappears is the *Cyprina islandica*. But in these clays, indeed in all above the laminated clay, small and large stones, up to boulders of several tons in weight, are abundant. In some instances they bear longitudinal scratches, but they are deposited so irregularly that their lines lie in every direction; showing that while the origin of the lines or striæ was to be ascribed to the period and the processes of the boulder clay, the transport and distribution of the materials was connected with subsequent movements and the melting of floating masses of ice. At the close of the formation of this clay, and on its surface, appeared patches of a well-known shell, *Mytilus edulis*, the common mussel. (5.) Closing the series is a covering of varying thickness, and composed of various materials. There sometimes appeared near the surface a coarsely laminated clay, which had occasionally been mistaken by observers for the more finely laminated clay to be found at the commencement of the series. A long period, however, must have intervened between the two, and he suggested a careful scrutiny as to the facts connected with these two distinct clays.

DUBLIN

Royal Geological Society of Ireland, February 14.—Francis M. Jennings, F.C.S., in the chair. The honorary secretary, Dr. Alexander Macalister, read the annual report of the council. The following officers for the ensuing year were then elected by ballot:—President—Dr. Alex. Macalister. Vice-presidents—Earl of Enniskillen, Colonel Meadows Taylor, J. Emerson Reynolds, Rev. H. Lloyd, F.R.S., and Sir Richard Griffith, Bart. Treasurers—William Andrews and Dr. Samuel Downing. Secretaries—Rev. S. Haughton, F.R.S., and Edward Hull, F.R.S. Council—Sir Robert Kane, F.R.S., Alphonse Gages, B. B. Stoney, W. Frazer, Dr. Alex. Carte, W. H. S. Westropp, C. R. C. Tichborne, F.C.S., Rev. Maxwell Close, Francis M. Jennings, F.C.S., Dr. Ramsay H. Traquair, Dr. J. Barker, J. Ball Greene, W. H. Baily, F.G.S., W. Ogilby, F.G.S., and R. A. Gray.—Prof. Hull, Director of the Geological Survey of Ireland, read a paper on a remarkable fault in the New Red sandstone of Whiston, Cheshire. The position of this fault is marked on the geological survey maps of Lancashire (one inch map 80 N.W.) as forming the boundary between the little isolated tract of coal measures, one mile west of Rainhill Station and the New Red sandstone. The fault ranges in a nearly meridional direction, and on the west the upper coal measures, with spirorbis limestone (first discovered by Mr. Binney, F.R.S.), are brought to the surface, and on the east the upper mottled sandstone of the Bunter division of the Trias. The Corporation of St. Helen's, in order to increase the water supply of the borough, commenced sinking a well, on Mr. Hull's recommendation, at a distance of 200 yards from the fault in the New Red sandstone close to Cumber Lane Bridge.* This well was carried down 75 yards, and from the bottom a bore hole, 18in. diameter, was driven 35 yards farther; but at 104 yards from the surface it passed through the fault, and entered hard micaceous sandstone of a purple colour belonging to the upper coal-measures. As the horizontal distance from the outcrop of the fault where it crosses the railway is 200 yards, and the depth 104 yards, it appears that the slope of the fault is about two horizontal to one vertical, or 28° from the horizontal. The usual slope of the faults in South Lancashire being two vertical to one horizontal, such a result was unexpected, and as the thickness of New Red sandstone was thus reduced below the calculated amount the quantity of water obtained (about 400,000 gallons per day) was consequently much less than that required and anticipated.

February 22.—A paper was read from Mr. G. H. Kinahan "On the Formation of Valleys and Lake-basins, with special reference to Lochlomond." The author dissented from the views which had been put forth by several eminent geologists as to sub-aerial denudation; and held that the principal valleys both in Scotland and Ireland lay along lines of faults or fissures

* This site was selected, not as being the best for water supply, but the best available.

in the subjacent rocks. In the highlands of Scotland, so far as he had observed, there was not a valley, ravine, or lake-basin unconnected with a break or fault in the strata ; and instanced particularly the Caledonian Canal, Loch Awe, Glencoe, Loch Fyne, and Lochlomond. He considered the deep parts of the latter lake were due to the meeting or crossing of two or more breaks, where consequently the rocks were fractured to a greater extent. Some of the dislocations, he was inclined to think, had been post-glacial.

PARIS

Academy of Sciences, April 15.—M. de Saint-Venant read a memoir on the intensity of the forces capable of deforming ductile cylindrical blocks placed under various conditions.—M. J. Boussinesq read a memoir on the influence of the centrifugal forces upon the varied permanent flow of water in prismatic channels of great width.—M. de Saint-Venant presented a note by M. E. Combescure on a process of integration by successive approximations of the equation

$$4\left(\frac{d^2\psi}{dxdz}\right)^2+\left(\frac{d^2\psi}{dx^2}-\frac{d^2\psi}{dz^2}\right)^2=4K^2$$

in plastic dynamics.—MM. P. A. Favre and C. A. Valson presented a continuation of their researches upon crystalline dissociation. This paper contains the first part of their investigations on the alums.—A note by M. Lecoq de Boisbaudran on the spectrum of the vapour of water. The spectrum was obtained by passing an induction current through a tube filled with rarefied aqueous vapour ; the spectrum consists of white stratifications, the light of which is resolved into four principal lines.—Several papers relating to auroras were read, including a note by M. Chapelas on polar lights observed in Paris on the evening of April 10; one by M. Tarry, communicated by M. Le Verrier, on the prevision of magnetic auroras by means of terrestrial currents, as applied to the aurora of April 10 by M. Sureau ; a general investigation of auroras by M. Heis, including a long list of parallel occurrences of such phenomena in the northern and southern hemispheres during the years 1870 and 1871 ; and a note by M. Linder on the theory of auroras, in which the author concludes that they are electro-magnetic phenomena which have their seat chiefly in the upper regions of the atmosphere.—M. Loewy presented a note on the discovery of two new planets, 119 and 120, one observed in Paris on April 9 by M. Paul Henry, the other at Marseilles on April 10 by M. Borelly. The positions of these planets on April 11-13 are given.—M. Berthelot read a note on the heat of formation of the oxygenated compounds of nitrogen. —M. A. Gillot presented a claim of priority with respect to a paper read by M. Gruner on January 22 on the action of oxide of carbon on iron and its oxides.—M. Cahours presented a note by MM. L. Dusart and C. Bardy on the phenoles.—M. Boussingault presented a note by M. A. Muntz on the statics of the cultivation of hops, containing a statement of the elements assimilated by the hop plants grown upon thirty-eight ares, and upon one hectare of land at Wörth.—A note by M. C. van Bambeke on the first effects of fecundation upon the ova of fishes and on the origin and interpretation of the mucous or glandular lamella in the osseous fishes was presented by M. de Quartrefages. The author stated, as the result of his researches, that under the influence of fecundation the germinal disc of the egg in osseous fishes divides into two layers, of which the upper one becomes segmented, whilst the lower one forms an intermediate layer between the segmented blastoderm and the vitelline sphere, and accompanies the former in its development around the latter. He regards the thin central portion of this intermediate layer as the homologue of the mucous lamella.—M. A. Gaudry read a paper on the fossil animals of the Léberon in Vaucluse. These fossils are chiefly mammalian, and present a remarkable anology to those of the Miocene deposits of Pikermi in Attica, investigated some years since by the author.—M. A. Brongniart presented a note by M. de Saporta "On the more precise determination of certain Jurassic Coniferous Genera by Observation of their Fruits." The genera here referred to are *Brachyphyllum*, *Pachyphyllum*, *Echinostrobus*, *Cunninghamia*, *Widdringtonia*, *Palæocyparis* (a new genus proposed for some species described as belonging to *Thuyites*), and *Phyllostrobus* (a new genus allied to *Thuja*).—M. de Quatrefages communicated a note by MM. E. Massenat, P. Lalande, and Cartailhac "On the Discovery of a Human Skeleton of the Reindeer period at Laugerie-Basse in the Dordogne."—M. A. Milne-Edwards read some researches upon fossil birds, containing a sort of summary of the results of his long-continued investigation.—M. L. V. Turquan submitted to the judgment of the Academy the description of an apparatus for indicating the presence of fire-damp in mines.

BOOKS RECEIVED

FOREIGN.—(Through Williams and Norgate.)—Anatomische-systematische Beschreibung der Alcyonarien, 1te Abtheilung, die Pennatuliden : A. Kölliker.—Morphologie u. Entwickelungs-geschichte des Pennatulidenstammes, nebstallgemeinen Betrachtungen zur Descendenzlehre: A. Kölliker.—Beiträge zur Anatomie der Plattwürmer : Sommer u. Landois.—Index der Petrographie u. Stratigraphie der Schweiz u. ihrer Umgebungen : B. Studer.—Geschichte der Himmelskunde nach ihrem gesammten Umfange, Parts 1-3 : J. H. v. Mädler.—Hydra, eine anatomische entwickelungs-geschichtliche Untersuchung : Dr. N. Kleinenberg.

DIARY

THURSDAY, APRIL 25.

ROYAL SOCIETY, at 8.30.—On a Supposed Periodicity in the Elements of Terrestrial Magnetism, with a Period of 26½ Days : The President.—Contributions to Formal Logic : A. J. Ellis, F.R.S.
LONDON INSTITUTION, at 7.30.—On the Effects of Certain Faults of Vision on Painting, with especial reference to the Works of Turner and Mulready : Dr. Liebreich.
ROYAL INSTITUTION, at 3.—On Heat and Light : Prof. Tyndall, F.R.S.

FRIDAY, APRIL 26.

ROYAL INSTITUTION, at 9.—On the Genius and Character of the Modern Greek Language : Prof. Blackie, F.R.S.E.
QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, APRIL 27.

ROYAL INSTITUTION, at 3.—The Star-Depths : R. A. Proctor.
GOVERNMENT SCHOOL OF MINES, at 8.—On Geology : Dr. Cobbold.

SUNDAY, APRIL 28.

SUNDAY LECTURE SOCIETY, at 4.—On Geographical Influences on History : Prof. John Young, M.D.

MONDAY, APRIL 29.

ZOOLOGICAL SOCIETY, at 1.—Anniversary Meeting.
LONDON INSTITUTION, at 4.—Elementary Botany, with special reference to the Classification of Plants ; Prof. Bentley, F.L.S.

TUESDAY, APRIL 30.

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

WEDNESDAY, MAY 1.

ROYAL INSTITUTION, at 2.—Annual Meeting.
SOCIETY OF ARTS, at 8.—On Telegraphy without Insulation, the means of cheapening Internal Communication : H. Highton.
MICROSCOPICAL SOCIETY, at 8.

THURSDAY, MAY 2.

ROYAL SOCIETY, at 8.30.
SOCIETY OF ANTIQUARIES, at 8.30.
LINNEAN SOCIETY, at 8.—On *Alibertia edulis* : Señor Correa de Mello.
CHEMICAL SOCIETY, at 8.
ROYAL INSTITUTION, at 3.—On Heat and Light : Prof. Tyndall, F.R.S.

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ERRATUM.—Mr. J. J. Hall requests us to correct an error in the "Contents" of our last number, whereby he is described as "F.R.S." instead of "F.M S."