THURSDAY, SEPTEMBER 21, 1871

THE SMITHSONIAN INSTITUTION

AN excellent article in the *New York Journal of Commerce* makes us acquainted with several points in the organisation of the Smithsonian Institution—that most cosmopolitan of our existing scientific organisations—to which we are anxious to draw attention. It is too much to hope for a similar institution in this country, but it is, nevertheless, interesting to watch the development of the American one under the wise direction of Prof. Henry.

Many years ago the Institution established what is known as the "Smithsonian system of exchanges," whereby, in exchange for those of America, the scientific publications of societies and individuals throughout the civilised world are placed without cost within easy access of the student of science in this country.

This system, promising at its inauguration all that could be expected, rapidly expanded, and during the past few years has yielded an abundance of fruit in the way of a knowledge of the progress of science in every part of the world, far exceeding the anticipation of its most sanguine supporters. Indeed, so eminently beneficial, not only to the scientific, but to the general interests of the country, has the system proved, that Congress a few years since directed the establishment, on a similar plan, of an international exchange of official publications, to be placed under the especial charge of the Institution, and voted, as a basis of operations, for distribution, fifty complete sets of the documents of the Fortieth Congress. These will shortly be ready for transmission by the Institution, in the name of the United States, to such foreign Powers as have either requested to be included in the list of exchange, or in some other way announced their approval of the plan, and are, therefore, known to be prepared to return similar publications of their own Governments respectively. Thus, in time, will be added to the great Congressional library a fund of knowledge which can hardly fail to be of vast importance to this Government.

It is mainly through its system of exchanges that the Institution has accumulated, and will continue to increase, that vast storehouse of scientific truths denominated the "Smithsonian Library," which, numbering about 70,000 volumes (inclusive of pamphlets, &c.), contains, besides complete series of the Transactions of many of the older societies of England and France, which it would now be difficult, if not impossible, to replace, hundreds of works which, like those of the societies in question, can be obtained in no other way than by exchange. On account, however, of the limited space provided for its proper accommodation in the Smithsonian building, but chiefly owing to danger from fire, the Institution a few years ago transferred its library to the Capitol, where, in company with the library of Congress, it still continues to occupy fire-proof roomy quarters. With regard to the library, the secretary of the Institution, in his last printed report, remarks: "The transfer of the Smithsonian Library still continues to be approved by all who have attentively considered the advantages it affords the Institution, the Government, and the public;" . . . that while, "by its transfer the Smithson fund has been relieved of a serious burden in the cost of binding and cataloguing the books . . . it has enriched the library of Congress with a class of valuable works which could scarcely be procured by purchase, and has facilitated the use of the books by collecting them in one locality, under the same system, readily accessible to the public." Again, Prof. Henry remarks: "The library of Congress, or, as we think it should now be denominated, the 'National Library,' contains about 180,000 volumes" (1868). . . . This library is, emphatically, a library of progress, for while it continues to increase by purchase in its own series of standard works at all times, its additions through the contributions of the Institution include the Transactions of the principal learned societies of the world, or the works which mark more definitely than any other publications the actual advance of the age in higher civilisation;" adding, in order to counteract the impression that the Institution, since the transfer of its library, no longer desires to receive books, "that no change in this respect has taken place in the policy of the Institution." It is gratifying to learn that this is the case; and to know that while Congress uses the books, it carefully cares for them.

On account of the large expense attending the transmission of a few packages when the Institution first put in operation its now great system of exchange, but owing much more to the greater expense that it was anticipated would have to be met in connection with return transmissions for American addresses; and, moreover, since the total charges for transportation both to and from the United States would have to be defrayed almost entirely by the Institution, while the results of its efforts would be placed at the free command of all, both organised bodies and individuals; it was soon found necessary to attempt to secure reduced rates for its ocean freight. In addition, it was absolutely requisite that foreign ports should be opened to the entry free of duty of the packages of a scientific character bearing the Smithsonian label; and to the accomplishment of both these ends the eminent head of the Institution bent every energy. Upon a proper presentation of the subject, the leading steamship lines plying between the United States and foreign countries, besides several companies sailing in waters exclusively foreign (with merely representative houses in this country), one after another became impressed with the importance of scientific intercommunication between the Old and the New World, as developed under the Smithsonian system, until now all, with great liberality, grant free freights to books and specimens interchanged under the auspices of the Institution.

With the ports of the rest of the world open to the free entry of scientific truth, the continuance on the part of Italy, year after year, to withhold from her people this right, was long deemed sufficient cause for the suspension, by the Institution, of inter-communication in the line of transmission of books and specimens. But not till three years ago did such suspension take place, and then solely because of the great expense to the Institution, on account of taxes levied at Italian ports on parcels whose contents, while purely of a scientific character, were intended as presents to that people. The suspension, however, was but for a brief period. A knowledge of the cordial welcome which American contributions to science had always met with at the hands of the principal scientists and learned bodies of Italy, was sufficient to convince the Institution that a cessation of intercourse would last but a short time, while it would terminate beneficially to both parties. The result was as predicted. Shortly after the stoppage of transmission, there was manifested by the scientific portion of the Italian people a strong desire that it should be resumed. Negotiations were soon begun, and after two years Italy acceded free entry to parcels bearing the familiar endorsement of the Institution. The decree guaranteeing this right may properly be said to mark an epoch in the history of the Smithsonian Institution, as well as in that of the advance of scientific education. The Institution has a printed catalogue of foreign correspondents, numbering nearly 1,600 learned bodies, and, in addition, an extended manuscript list of individuals with whom it is in correspondence abroad, which embraces the names of the most eminent *savans* of the Old World. This shows that outside the United States, the policy of the Institution is everywhere highly endorsed; while fresh evidence of the fact is continually being received from new organisations, having for their object the advancement of science, in the form of applications for enrolment in the Smithsonian list of correspondents.

With no desire for a knowledge of the terms of the bequest, and satisfied as to the correctness of their own opinion that Smithson's gift was solely for the people of the United States, many Americans do not approve of extending the benefits of the said gift beyond the narrow limits of the land in which they themselves reside. In so enlightened an age, and with Smithson's will easily accessible, the error of such an opinion is unpardonable.

The mistake made by Congress, however, shortly after the bequest was accepted, is in a measure to be excused. The trust was of a novel character, while the instrument conveying it to the care of the United States made known but briefly the design of the giver. The life and character of the testator ought to have been closely investigated in order to arrive at a proper appreciaion of the true spirit of the terms upon which the money was given and accepted. It would appear that without an investigation of this kind, or certainly without a knowledge of Smithson's intention, Congress directed the management of the interest from the fund, for a few years immediately subsequent to its acceptance by the United States Government, in such manner as to divert the bequest for a long time almost entirely from its legitimate purpose. Several hundred thousand dollars yielded by a fund left for the "increase and diffusion of knowledge among men," was sunk in "brick and mortar." Had the amount expended in the erection, not to speak of the large sums paid out for the maintenance and repair, of the stupendous structure known as the Smithsonian building, been added to the principal of the original fund, the Institution would have been enabled to realise to a much fuller extent than has been done the anticipations of the generous foreigner whose name it perpetuates. While many were convinced of the fact at the time the fund was accepted, it is now universally admitted that for the "increase and diffusion of knowledge," brains and the printing press are the essential requisites, and that for the accommodation of these a building of moderate size and of small cost is all that is needed. The Smithsonian Institution, however, the especial object of which is that just set forth, continues to occupy a structure which in point of dimensions is vastly more extensive than is needed for its operations. The cost of maintaining such an edifice is very great, while, owing to its peculiar style of architecture, contingent repairs are frequent as well as expensive. It is to be hoped that the building will, before long, become the property of the Government, and the purchase money be added to the present Smithson fund. This vast edifice is suitably adapted to the exhibition of a Museum on a scale worthy the capital of the nation. The nucleus of such an establishment is already cared for by the Institution, but, although belonging to, is not maintained entirely at the expense of, the Government. The purchase in question of this building would be an acknowledgment of the intention of the United States to correct, as far as possible, the errors committed when the trust was accepted, and would prove an earnest to the people of other lands (for whom, equally with ourselves, the gift is designed) that the trustees of the munificent liberality of Smithson intended hereafter to carry out his wishes according to the letter and spirit of his will.

The efforts of the distinguished head of the Institution so to conduct the establishment as that the greatest good may eventually result to the greatest number, are appreciated far and wide, while his untiring devotion tɔ the cause of education has rendered his name familiar to the most distant portions of mankind.

PHYSIOLOGICAL RESEARCHES AT GRATZ

Untersuchungen aus dem Institut für Physiologie und Histologie in Gratz. Herausgegeben von Alexander Rollet. Zweites Heft. (Leipzig: Wilhelm Engelmann, 1871. London: Williams and Norgate.)

THIS record of Histological and Physiological research in Styria contains a series of interesting and important papers.

The first of these is one by the editor on the classification of tissues. Nearly every author who has written on Histology generally has put forth some classification or other. Amongst these, that of Dr. Beale in Todd and Bowman's "Physiological Anatomy and Physiology" (Ed. 1866, p. 70) is cited as one of the worst and most illogical. It is a difficult question to determine what are and what are not elementary units of histological structures. Dr. Rollet founds his classification, as far as possible, on the data afforded by the history of the development of the tissues. Thus, endothelial structures are classed with connective tissue, and separated entirely from epithelial, as being developed in the pleuroperitoneal cavity of the embryo. The classification arrived at is as follows:—

1. Sencocytes.
2. Red blood corpuscles.
3. Elementary parts of connective tissue.
4. Elementary parts of fatty tissue.
5. Elementary parts of muscular tissue.
6. Elementary parts of nerve tissue.
7. Elementary parts of epithelial tissue.

This classification seems to be an excellent one. For its further development we must refer to the paper itself.

A paper on the septic glands of the stomach by Dr. Rollet follows the former, and is most exhaustive in character, and the fact that the methods by which the results have been arrived at are most carefully described is especially to be commended. A new carmine solution is recommended which we have tried with excellent results. It has the advantage of being neutral, and of allowing of the addition of a certain amount of acid without suffering precipitation. It is prepared by boiling for five hours 35 grains of carmine with 270 cc. of dilute sulphuric acid (one volume of concentrated acid to fifteen volumes water), the volume being kept constant by the addition from time to time of water. The resulting solution is filtered and diluted with four times its volume of water. The sulphuric acid is then neutralised with carbonate of barium, and the solution quickly filtered. As soon as the filtrate has run off, a fresh quantity of water is poured on the precipitate, and comes through strongly coloured. Four or five filtrates may thus be obtained. The first two do not keep well, the third, fourth, and fifth do. From these solutions may be obtained what is called by Dr. Rollet carmine-red, which is soluble in distilled water.

It is too much the fashion amongst English histologists to aim at staining the nuclei only of the cells of tissues, whereas what is far more valuable is a clear definition of the boundaries of the cell itself. This result is in most cases only to be obtained by using a perfectly neutral solution of carmine such as the one just described. Dr. Rollet has found it yield very good results in cases where carminate of ammonium had failed. It would probably be found very good for silver preparations.

In a short notice it is impossible to do justice to such a paper as this. Dr. Rollet describes the glands of the rabbit, cat, dog, ox, sheep, pig, hedgehog, and other animals. He has also compared the appearance presented by the glands of the hybernating and active bat. The journal contains also an account of a "Commutator for Batteries in Physiological Laboratories," invented by Dr. Rollet; a paper on the "Development of Spermatozoa," by Dr. Victor V. Ebor, of great importance; another, on the "Glands of the Larynx and Trachea," by Dr. Mathias Boldyrew, who describes glands in all respects resembling pyers glands, as occurring occasionally in the larynx of the dog; and "Remarks on the effects of the administration of small quantities of curare in successive injections," by Julius Glase. The results are very remarkable. The animal becomes at each injection more and more sensitive to the poison, and finally reaches a state in which an extremely small quantity produces immediate convulsions and even death. Moreover, the injections may be intermitted for days and yet the animal remain as sensitive as before. The author believes that the system becomes adapted to the poison in such a way as to absorb it more rapidly, or that an actual change in some of the nervous centres occurs. Of course we cannot consider this a case of so-called cumulative poisoning, since the animal remains apparently perfectly healthy between the doses. The last paper is one on the "Ciliated Epithelium of the Uterine Glands." The author, Dr. Gustav Sott, has observed cilia in motion in the uterus of the cow, sheep, pig, rabbit, and moose. H. N. M.

OUR BOOK SHELF

A History of British Birds. By the late William Yarrell, V.P.L.S., F.Z.S. Fourth Edition, revised by Alfred Newton, M.A., F.Z.S. Parts 1 and 2. (London: Van Voorst, 1871.)

"YARRELL'S British Birds" is without doubt one of the best known and most widely appreciated books on Natural History ever published in this country, and has probably done more than any other work to excite and augment an interest in one of the most attractive branches of zoology. At the same time, "Yarrell's Birds" is neither cheap nor popular in the ordinary sense of these terms, and the fact of three large editions of it having been sold, and a fourth being now called for, is a sterling proof of its extraordinary merits. The third edition of the work was issued in 1856, a few months before the author's death. For the editorship of the present (fourth) edition the publisher has secured the services of Prof. Newton of Cambridge, than whom no one is better qualified for the undertaking. Moreover, what is of still greater consequence, it may be added that, so far as we can judge from the parts of the work that have as yet reached us, Prof. Newton has set about the task entrusted to him in a very thorough way. As has been observed in the prospectus of the new edition, the literature of the subject has been nearly doubled within these last thirty years—that is, since the date of the publication of Mr. Yarrell's original work, while even since the issue of the last edition an extraordinary augmentation has been made of our knowledge of British Birds. "Very many of the species respecting which little was actually known in 1856 have been traced by competent observers to their breeding-quarters, and their habits ascertained, and in some instances minutely recorded." Mr. Yarrell's later editions having been little more than reprints of the original, with the intercalation of certain species recorded from time to time in the "Zoologist" and similar periodicals as "new British birds," it follows that a good deal of alteration and addition was necessary to bring the work up to the present standard of ornithological knowledge. This the new editor has apparently determined to effect, in spite of the vast amount of labour involved in so doing, which, on the whole, will fall little short of that of preparing an entirely new work on the subject. Such articles as those on the Griffon and Egyptian Vultures and the Greenland and Iceland Falcons in the first number require to be entirely rewritten, while material additions have to be made to the history of even the commonest species, particularly as regards their geographical range and their representation by allied forms.

The woodcuts of the present edition are mostly the same as those prepared for the original work.

It is certainly a decisive proof of the present popularity of ornithology, so far at any rate as regards the knowledge of our native species, that while Mr. Gould's "Birds of Great Britain" is still unfinished, and Messrs. Sharpe and Dresser have lately begun an entirely new work occupying nearly the same ground, a fourth edition of Mr. Yarrell's "History of British Birds" should be commenced with every prospect of permanent success.

P. L. S.

WE have lately received the last published Report on the progress of Entomology prepared in connection with the *Archiv für Naturgeschichte.* In the space of 226 pages it includes a review of all the works and papers published in 1867-68 on the subject of Entomology, taking that word in what may be called its Linnean sense, namely, as embracing the study of Insects, Arachnida, Myriopoda, and Crustacea. Of these reports, commenced by Erichson, continued by Schaum, and after his illness by Gerstäcker, it is impossible to over-estimate the value, for although the information contained in them upon the species and systematic matters is rather less detailed than in the English "Zoological Record," the notices of anatomical and physiological papers are fuller, and the student will always find indications of the direction in which to look for information on other subjects. The conductors of these useful Reports have always been in the habit of delaying their publication until the literature of each year could be analysed as completely as possible, and in the present issue we have only the particulars of the contributions to entomological knowledge published during the years 1867-68. The Insecta proper are reported upon by M. F. Brauer of Vienna, whilst Prof. Gerstäcker confines his labours to the Myriopoda, Arachnida, and Crustacea.

W. S. D.

LETTERS TO THE EDITOR

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

The Science and Art Department

BELIEVING your columns to be at all times open for the discussion of matters connected with Science and Art teaching, I venture to offer a few remarks on the administration of the above-named Department.

Since the arrival of the results of the last May examination, the teachers have been enabled to make up their claims for payment, and there has been a great outcry from all parts of the country on account of the serious reduction that has taken place in the amounts the teachers are entitled to claim for their work. This reduction arises from the operation of the last alteration by the Department of the scale of payments on results, the full effect of which was not felt until this year.

Many objections were raised at the time the minute was issued (in the latter part of 1869), especially to its being introduced after the commencement of the work of the session, and in deference to these remonstrances it was modified in its application to the May examinations of 1870, and its full operation deferred till the May just past. When I say just past I am speaking after the manner of the Department, for they are so far behind that the Annual Report for the Session of 1869-70 has not yet been received by the committees here.

Now I venture to submit that this reduction in the scale of payments is likely to have a very injurious effect on the spread of education in Science. In many cases, especially in small towns, and where a teacher has a class in only one or two subjects, the amount of payment to be received is so small as to give rise to the apprehension that such classes will be given up, because of the utter inadequacy of the payment to remunerate a teacher for the time and trouble spent in the work of instructing them. To give an illustration, I have just been informed of an instance where a teacher has had to proceed fourteen miles by rail to give his lectures to a class, and the result of the recent examination is that he received absolutely nothing from the Department in respect of this class, all those of the students who passed being persons of the middle classes.

When in conjunction with such facts as these we read that the payment for instruction in Science and Art in 1870 was 17,000*l.* less than in the previous year, there seems great reason for the complaints of the teachers, and one must, I think, come to the conclusion that the Department has proceeded too far in the direction of economy to be conducive to efficiency or to the continued spread of scientific instruction.

If the present scale is to be retained, I think the suggestion of a writer in the *Daily News* recently, that the system of payment by results alone should be modified, is worthy of consideration. The teacher often has the greatest amount of trouble with those students who just miss obtaining a certificate, and in these cases the master receives nothing at all for the labours of the session. It would be more encouraging to the teacher if a small payment was made for those students who have attended the required number of class lectures, although they may not be able to pass the examination for proficiency. Of course, there should be safeguards provided against the abuse of such a rule, say, by excluding from its operation all such as are unable to attempt a stated proportion of the questions propounded.

Even under the present arrangements I have seen many students sit idle the greater part of the evening, or leave the examination room as soon as permitted to do so by the regulations, through not being able to attempt to answer more than two or three questions.

With regard to another matter of which complaint has been made, viz., the recent minute of the Department imposing fines on Committees who ask for a larger number of papers than they require, I must say I cannot see the reasonableness of the complaint. At the last May examination in Plymouth, one school alone (according to the printed list issued by the department) sent up a requisition for 714 papers in the various subjects of Art and Science, while the total number of papers worked by pupils of that school, and by strangers whose papers were asked for through its committee, was only 339—less than half. If this case is at all a sample of what was occurring in the country generally, and the issue of the minute leads me to think such must have been the case, I consider it was quite time for something to be done to prevent such wholesale waste. Of course in all schools there will be a certain number who will shrink back at the last moment, after having given in their names for the examination, and this being fairly provided for, I do not see anything in this regulation that efficient schools and committees should complain of.

A LOCAL COMMITTEEMAN

Plymouth, Sept. 14

Elementary Geometry

I HAVE to thank the Editor of NATURE for inserting my letter, and Mr. Wilson for writing so fully. I was not aware when I wrote, that Mr. Wilson had himself published an elementary book on geometry He has modestly omitted to refer to it; but I have seen it, and it appears to me a suggestive book for a teacher. He acknowledges himself unable to recommend one suited to boys, for laying the foundation of geometry.

Mr. Wilson's advice seems rather suited to teachers of geometrical drawing than of mathematics. Of course it is essential that a boy should know what measuring means; but scales of measurement have no essential connection with geometry. Nevertheless, I entirely agree with him that much trouble must be taken to teach the metrical system, especially as it is not likely to be popularly used in England, at least while our children are living. To purchase a simple metrical rule is by no means an easy task. They are not kept, that I can find, at any *ordinary* instrument makers in London, Oxford, or Cambridge.

With your permission I will say what I think is required in a book for boys. It must, to a certain extent, be suitable for being committed to memory, as Euclid is. No child is capable of taking in a subject, especially if it involves logical thought, except by very slow degrees; and must at the beginning commit much to memory which he does not comprehend. What I write will appear, to those who do not know children, to involve a most vicious principle in teaching; but it is, nevertheless, a fact. Our new book must, therefore, contain all the steps of every proof in full, and no symbols must be used. In the next place, it must not be artificial. It seems agreed that the use of compasses ought to be of the nature of a postulate, which would at once get rid of such propositions as the second and third of Euclid. There can be no reason for excluding the idea of the motion of a point, since in practice no figures can be drawn except by moving the pencil's point. It appears then that, having once got over the difficulty of defining a point, a line should be "the path of a point," a definition which would easily lead on to the doctrines of curvature and tangents; and a straight line would be that which does not alter its direction (virtually Euclid's definition); and, as in Mr. Wilson's book, parallel straight lines, those whose directions are the same.

It seems to me that it would be better to retain Euclid's definition of proportion, only converting it into a *test* of proportion; because the constructions founded upon it are so convenient for geometrical purposes; and if it be superseded by the algebraical mode of treating the subject, reasoning on incommensurable quantities must be introduced.

In fine, the book which is to supplant Euclid appears to be at present a desideratum. When it appears, it probably must be the work of more heads than one, if it is to be generally accepted among teachers.

A FATHER

THE circumstances attending my own introduction to geometry lead me to doubt whether a long course of practical geometry is the best beginning. I believe that, on the contrary, unless the demonstrative and deductive principles of the science are soon introduced to the student's notice, he is likely to acquire a distaste for the subject.

I was learning, under an infliction of practical geometry (at school), to detest the very sight of a box of mathematical instruments, when a fortunate illness kept me at home for two or three years. I believe that Euclid, as it would have been introduced to me at school, would have rendered my dislike for mathematics complete. But becoming possessed of a Simson's "Euclid," and *reading* it instead of learning it for "class," I found geometry the most enjoyable of subjects. In a very few months I came to the end of the book, and I have never lost the liking for geometry which I had by that time acquired.

Let it not be supposed, however, that I advocate the claims of Euclid as a text-book. The first, third, and sixth books might indeed be retained—with certain omissions and modifications; but the second and fourth books (setting aside a few propositions) are monstrosities of clumsiness.* The fifth, eleventh, and twelfth could never be generally used in their present form. But whether a totally new text-book be adopted or Euclid be modified, I am convinced that until the demonstrative and deductive nature of the science is recognised the interest of the student will not be excited.

While, however, my own experience will not permit me to believe that a course of practical constructions is a suitable introduction to geometry, I certainly agree with Mr. Wilson in regarding careful constructions as of the utmost importance to the learner. But, in my judgment, the processes of construction should accompany, not precede, the study of some demonstrative and deductive treatise.

I believe the chief difficulty under which we labour at present, resides in the fact that, owing to the small encouragement given to the study of geometry at our Universities, we have, even among our ablest mathematicians, very few able geometricians. One cannot read the Cambridge text-books of mathematics—written though these are, in many instances, with singular ability—without becoming convinced of this. So soon as a geometrical construction is introduced we recognise the clearest traces of inaptitude. The fact is still more clearly evidenced in treatises professedly geometrical. I take up an edition of Euclid, prepared by a very eminent mathematician, a senior wrangler, and, opening at random the portion relating to deductions, I find the following problem:—"Required to draw a circle through a given point to touch two intersecting lines;" and to solve this obvious third-book problem the aid of the sixth book is called in.

But it is hardly to be wondered at that university mathematicians are, as a rule, not strong in geometry, for the study of geometry is very little encouraged by university tutors. Indeed, an aptitude for geometrical methods is generally regarded as more mischievous than useful in the Tripos. I can remember the hints I myself received on this point. A few instances may perhaps interest your readers.

The first hint was given me in the lecture-room by a high wrangler (an excellent geometrician). The following proposition had been submitted—"A ball is placed on a horizontal plane, above which is a luminous point; show that the length of the minor axis of the ball's elliptic shadow depends only on the height of the luminous point above the plane." I wrote for answer that the fact is obvious, because two sloping planes touching the ball, and with a horizontal intersection through the luminous point, must clearly have the same slope wherever the ball is placed. The proof was accepted, and even regarded (to my infinite surprise) as ingenious; but I was warned not to leave the safe track of analysis.

The next hint was given me by my private tutor, a senior wrangler with fine (but untrained) geometrical powers, on the score of my solving geometrically some problems relating to epicycloidal and hypercycloidal areas.

The third hint was given me by a vacation tutor, also a senior wrangler, and was perhaps the best deserved of the three. He had set me a problem relating to a curve which chanced to be a projection of the four-pointed hypercycloid, and the problem was meant as an exercise in analytical processes. Knowing very little about these, I ventured to proceed *more meo*. I first projected the curve back again (so to speak), established the property in the case of the quadricuspid hypercycloid, and rejected all my constructions on the original plane of the curve. I shall never forget the solemnity of the warning I received.

The last case I shall refer to relates to a probability problem (the last in Todhunter's "Integral Calculus") about a messenger and a shower of rain, the messenger's "expectation" under certain stated conditions being expressed in the following pleasing form:—

$$\frac{v}{n}\left\{\frac{1}{2}-\frac{u}{v}+\frac{u\,(u+v)}{v^2}\log\frac{u+v}{u}\right\}$$

From the day that I gave a geometrical solution of this problem (the logarithm coming out as a hyperbolic area) I was given up as a bad job. No wonder, indeed, for as a problem in the Integral Calculus it can be solved in half-a dozen lines.

So little encouragement is given to geometrical work, that I know instances where men who have taken very high degrees could not solve the easiest geometrical problems. Many indeed in my time (I believe Mr. Wilson would confirm this) in their second or third year at Cambridge, scarcely know what has to be done with such problems—that is, even how to try to solve them. I wrote a little pamphlet four or five years ago, to show how such problems should be attacked, proceeding on the following plan:—I took the case of a beginner dealing with easy geometrical problems, and considered his difficulties and false steps, as well as the true demonstration ultimately evolved. I did this because I had found it the only effectual course with pupils. To give problems, and on the pupil failing to solve them, to show him the solution, is utterly useless. One must listen to his reasoning, wrong or right, to the purpose or not—show him why it is wrong, or not effective towards the solution of the problem; and so gradually guide him towards the correct solution. In the pamphlet I employed a corresponding method.

Unfortunately (for me at any rate) Messrs. Longmans submitted this pamphlet to "a competent mathematician," who immediately misunderstood my plan; took the imagined difficulties for real difficulties of my own, and solved for my behoof an immensely difficult problem—the first worked-out example in Potts's Euclid. This achievement (*par parenthèse* my pamphlet also) was then submitted to another competent mathematician, and he, excited to emulation, suggested another solution of a problem which a boy of twelve might safely attack. Finally, these labours were submitted to Messrs. Longmans and (signatures removed) to myself. So my pamphlet has remained in my desk; for I thought better of it than to send it begging.

We want geometricians more than text-books just now. If our universities would give geometry a reasonable position among the subjects for mathematical examination, we should probably soon have both. At present a man with geometrical tastes must either turn from his favourite subject during his university career (with small chance, perhaps, of resuming it) or must be content with but a small share of university success.

Brighton, September 15 R. A. PROCTOR

Captain Sladen's Expedition

IN reply to F.R.S.'s inquiry in your issue of September 14, I may state that the last number of the "Proceedings of the Zoological Society of London" (1871, part 1) contains several articles by Dr. John Anderson relating to discoveries made during Capt. Sladen's expedition to Yunan, and that the next number (1871, part 2), which I am now preparing for the press, will contain others.

It was Dr. *Thomas* Anderson, Curator of the Botanic Garden at Calcutta, whose untimely death we have recently to lament. Dr. *John* Anderson (his brother) is, I am happy to say, in good health at his official post as Curator of the Indian Museum and Professor of Comparative Anatomy at Calcutta, or was so, at all events, at the date of his last letters to me, about a month since.

11, Hanover Square, Sept 16 P. L. SCLATER

Deschanel's Physics

AS regards the particular passage in my edition of Deschanel which I am challenged to defend by your Reviewer (NATURE, vol. iii. p. 343), his charge, which is somewhat obscured by rhetorical embellishment, seems to be that in the factor $\frac{H-h}{760}$ it has not been indicated that H and h, as well as 760, denote so many millimetres of mercury *at zero*. I think this was scarcely necessary, as the question whether the observed or reduced heights of the mercurial columns should be employed, is not one on which

* All the propositions of Book II, save four, may be established (usually) in three lines from the first two, of which they are in fact little more than corollaries. The main objection to the fourth book relates to the inscription and circumscription of the regular figures; but throughout the book the heaviness of Euclid's method is much felt.

a doubt could occur to the mind of any intelligent reader, reduced heights being invariably employed in the chapter in which the passage occurs, and in the book generally.

The charge of inconsistency which the Reviewer urges with so much gusto, is based on the following passage in my Preface, at the beginning of Part I :—

"There is great danger in the present day lest science-teaching should degenerate into the accumulation of disconnected facts and unexplained formulæ, which burden the memory without cultivating the understanding. Prof. Deschanel has been eminently successful in exhibiting facts in their mutual connection ; and his applications of algebra are always judicious."

Which, the Reviewer thinks, justified the expectation that I would omit as many as possible of Deschanel's applications of Algebra. It is not surprising that a writer accustomed to this style of inference should have an aversion to exact reasoning, and should characterise the solution of problems by the application of a little algebra as "intricate formulæ, which burden the memory without cultivating the understanding."

I may remark, with reference to my former discussion with W. M. W. in your pages, that the adoption of concrete units of mass, and derived units of force, has now received the official sanction of Sections A and G of the British Association, who have appointed a committee to frame a system of nomenclature on this basis. J. D. EVERETT

Newspaper Science

KNOCKED up with work, I reluctantly followed the advice of my medical man, and crossing the Channel so as to be more out of the way, resolved to eschew everything scientific for the next few weeks at least, in order to recruit before the winter's labours commenced. Even here, however, I soon found that the desired result was not so easily attainable as I had imagined, for the first thing this morning, on entering the reading room of the bathing saloon, a French acquaintance, placing the *Globe* (of Monday evening, September 11) before me, directed my attention to its leading article on Prussian Artillery, adding significantly—"*Voilà, mon ami*, a specimen of English scientific opinion !"

I must confess that it was not without a feeling of shame that I read an article, of which the following extracts will suffice to give a correct idea.

"Although the unchequered course of the late war was due to many causes, still it is now admitted on all sides that when the Krupp guns were brought into the field the conclusion was practically foregone." "The first public exhibition of what is now known as the Krupp gun was the gigantic specimen of a breech-loading steel gun sent to our Exhibition of 1851. The steel of which this gun was made differs entirely from our *Sheffield gun metal* or from Bessemer metal, and is a *composition invented by Krupp*, and the result of a special process. The iron is alloyed *with certain clays and also with a preparation of plumbago.* There are 100,000 '*creusets*' of this metal always in active employment in the factory, and each '*creuset*' contains from twenty to forty kilogrammes. The metal in a fluid state is poured into large cylindrical moulds, where it remains for two hours till it has completely hardened. But the chief difficulties of the process lie in subjecting it to the steam hammer. For years the hammer of greatest power in the factory had a force of 25,000 *kilometres*," &c. !

The italics are mine, and any one conversant with such subjects will perceive that no further comments are required. It only remains for me to express my astonishment at seeing such rubbish appear in the leading article of any newspaper of standing, and I am sure your readers will agree with me that it is high time that journals specially devoted to science should protest energetically against such representations being conveyed to the public at home and abroad as expressions of English technical or scientific opinion. DAVID FORBES

Boulogne-sur-Mer, September 13

THE NEW GANOID FISH (CERATODUS) RECENTLY DISCOVERED IN QUEENSLAND

AT the beginning of last year news reached Europe that a large "Amphibian resembling *Lepidosiren*" had been discovered in Australia, and the curiosity of naturalists was still more excited when it was stated that this creature was provided with teeth extremely similar to the fossil teeth (from the Jurassic and Triassic formations) known under the name of *Ceratodus*.

The interest attached to such a discovery will be easily understood, if we review briefly the history of *Lepidosiren*, and show the advance made by zoology in consequence of our acquaintance with this animal.

The discovery is due to the well-known Austrian traveller, Natterer, who sent two examples from Villa Nova on the Amazon River and the Rio Madeira to the Vienna Museum in the year 1837. Fitzinger, then Curator of the Collection of Reptiles, gave a somewhat superficial description of it under the name of *Lepidosiren paradoxa*, referring it without hesitation to the class of Reptiles. Nearly at the same time a very similar animal was found by Mr. Th. C. B. Weir, in Senegambia ; he presented two small examples to the Royal College of Surgeons ; and Prof. Owen, then Curator of the Hunterian Museum, published a full description of them under the name of *Lepidosiren annectens*, in the year 1839, explaining the reasons which induced him to regard this creature as a Fish. This view elicited further examination of the internal structure of the American species by Profs. Bischoff and Hyrtl, the former inclining to the opinion expressed by Fitzinger, the latter confirming, to the satisfaction of nearly all zoologists, the correctness of the conclusion arrived at by Owen.

Before the discovery of *Lepidosiren*, zoologists distinguished the class of Reptilia from that of Fishes by the organ of respiration, the former being provided with membranous lungs extending into the abdominal cavity, the latter breathing by gills only. Although the Batrachian reptiles were known to breathe by external gills, as fishes, during the early stage of their metamorphosis, and although some of them retain those gills through the whole period of their life, yet the development of lungs in the adult state and the co-existence of these organs with gills in the Perennibranchiates, were considered to be sufficient indications of their class-distinctness from fishes, among which no air-breathing organ was known. It is true Harvey and Hunter had pointed out that the air-bladder of the fish was homologous with the lung of higher vertebrates ; but functionally it could not be compared to it, as it receives arterial blood like any other abdominal organ, returning it in a deoxygenised condition.

Now *Lepidosiren* was found to be provided with gills, and a most perfect paired lung communicating by a ductus pneumaticus and glottis with the œsophagus, receiving venous blood by strong arteries, and sending it back directly to the heart in an oxygenised condition. Therefore, in this respect it did not differ from an Amphibian, and dogmatical believers in the stability of our zoological systems felt themselves quite justified in referring this creature to the Reptilians.

Nevertheless, the presence of certain other peculiarities of structure indicated rather an ichthyic than a reptilian affinity. The notochordal skeleton, and the apophyses arranged as in many fishes, and not as in Amphibians ; the organ of hearing enclosed in the cartilaginous capsule of the skull ; the dentition extremely similar to that of a Chimæra ; the intestinal tract traversed by a spiral valve ; peritoneal outlets near the vent ; no nasal canal to conduct air ; finally, the skin covered with scales, the fins supported by fin rays. All these are characters not found in Batrachians, and connect *Lepidosiren* with the class of Fishes ; but it was admitted that it makes the nearest approach in that class to the Perennibranchiate Amphibians.

The question had next to be settled, what place in the class of Fishes should be assigned to *Lepidosiren ;* and as the view entertained by Joh. Müller is that adopted by the majority of zoologists, we think it sufficient to refer to it alone. Having determined that all Ganoid Fishes agree with the Sharks and Rays in having an additional muscular division of the heart at the origin of the aorta, named *bulbus* *arteriosus*, and provided with transverse series of valves in its interior, he found that such a *bulbus arteriosus* was likewise present in *Lepidosiren*, but with a very different valvular arrangement. This peculiarity, combined with the development of a lung, he considered to be sufficient to distinguish *Lepidosiren* as the type of a separate subclass, which he named *Dipnoi*, and placed at the head of the entire class.

Thus, then, *Lepidosiren* was finally placed among the Fishes; but from the time of its discovery dates the tendency of zoologists to subdivide the assemblage of cold-blooded animals *not only where the development of a lung ceases, but also where the development of gills begins.* Or, in other words, systematists became more and more convinced that the old division of Reptiles and Fishes was insufficient, and that three classes of living cold-blooded Vertebrates should be distinguished, viz., Reptiles, Amphibians, and Fishes, some regarding the second as even more closely allied to the third than to the first.

When we find a group of animals represented by a very small number of forms in the existing Fauna, we look to Palæontology to fill up the seeming blanks; but *Lepidosiren* did not appear to have any fossil representatives. Prof. Owen stated (in 1839) that its teeth resembled "in their paucity, relative size, and mode of fixation to the maxillæ, those of the *Chimæra* and some of the extinct cartilaginous fishes, as *Cochliodus* and *Ceratodus*;" but no further inference was made from this fact as regards affinity. And Prof. Huxley (in 1861), when drawing attention to analogous structures in *Lepidosiren* and certain Devonian fishes, still maintained the entire absence of the Dipnoous type in the fossil state.

The discovery of a "gigantic Amphibian allied to the genus *Lepidosiren*, from rivers in Queensland," and named *Ceratodus Forsteri* by Mr. Krefft, promised to mark another step in the advancement of our knowledge, and to lend additional aid in determining the natural affinities of these animals. As soon as Mr. Krefft had recognised the importance of this discovery, the trustees of the Australian Museum of Sydney took steps to secure well-preserved examples. They sent a collector into the district where the animal was known to occur; and, with their usual liberality, they despatched to the British Museum, for examination, the first specimens they could spare, by which I was enabled to present a full account of its organisation to the Royal Society. It is not my intention to enter here into the details of the results of this examination; I must be satisfied with giving a short description of it, pointing out some of the bearings which this discovery has upon the advancement of science.

The fish (for this it proved to be, and even more so than *Lepidosiren*) appears to be not uncommon in some districts of Queensland; specimens have been obtained from the Burnett, Dawson, and Mary rivers, some high up in perfectly fresh water, others descending into the lower brackish portions. It is said to grow to a length of six feet, the largest example sent to the British Museum being about three and a half feet long. The flesh is excellent eating, and of salmon colour, hence it is called by the squatters Burnett or Dawson salmon. Its food consists of the decaying leaves of myrtaceous and other plants, with which the stomach and intestine are crammed. Probably now and then it swallows, perhaps accidentally, some aquatic animal; but it is rather doubtful whether it can be caught by using living animals as bait. It is also stated that it is in the habit of going on land, or at least on mud-flats; and this assertion appears to be borne out by the fact that it is provided with a true lung. On the other hand, we must recollect that a similar belief was entertained with regard to *Lepidosiren*, of which now numerous examples have been kept in captivity, but none have shown a tendency to leave the water. I think it much more probable that this animal rises now and then to the surface of the water, in order to fill its lungs with air, and then descends again until the air is so much deoxygenised as to render a renewal of it necessary. When we recollect that the animal evidently lives in mud or in water charged with the gases which are the product of decomposing organic matter, the usefulness or necessity of such an air-breathing apparatus, additional to the gills, becomes at once apparent. Further we shall see that the limbs of this unwieldy and heavy animal are much too feeble and flexible to be of much use in locomotion on land; they may assist it in its crawling, in water, over the muddy bottom of a creek; but the chief organ of locomotion is the compressed, broad, and flexible tail, denoting by its shape and structure that the fish can execute rapid swimming motions. However, it is quite possible that it is occasionally compelled to leave the water, although I do not believe that it can exist without it in a lively condition for any length of time. It is said to make a grunting noise, which may be heard at night for some distance. This noise may be produced by the passage of the air through the œsophagus, when it is expelled for the purpose of renewal.

It deposits a great number of small eggs, which are impregnated after deposition. Nothing is known of their development; but we may infer that the young are provided with external gills, like those of some other Ganoid Fishes.

The *Barramunda* (we will use the name given to it and other similar fishes by the natives) is eel-shaped, but considerably shorter and thicker than a common eel, and covered with very large scales. The head is flattened and broad, the eye lateral and rather small, the mouth in front of the broad snout and moderately wide. The gill openings are a rather narrow slit on each side of the head. There are no external nostrils. The tail, which is of about the same length as the body without the head, is compressed, and tapers to a point, but it is surrounded by a very broad fringe, supported by innumerable fine and long fin-rays. There are two fore and two hind paddles, similar to each other in shape and size, and very different from the fins of ordinary fishes; their central portion being covered with a scaly skin, and the entire paddle surrounded by a rayed fringe. If we were to cut off the hind part of the tail of a fish, the piece would bear a strong resemblance to one of the paired paddles. The vent is situated in the median line of the abdomen between the paddles.

In order to obtain a view of the inside of the mouth, it is necessary to slit it open, at least on one side. We then notice that there are a pair of nasal openings within and on each side of the cavity of the mouth. The palate is armed with a pair of large, long, dental plates, with a flattish, undulated, and punctated surface, and with five or six sharp prongs on the outer side, entirely similar to the fossil teeth described under the name of *Ceratodus*. Two similar dental plates of the lower jaw correspond to the upper, their undulated surface fitting exactly to that of the opposite teeth. Beside these molars the front part of the upper jaw (vomer) is armed with two obliquely placed incisor-like dental lamellæ, which have no corresponding teeth in the lower jaw. As we know the kind of food taken by the Barramunda, the use of their teeth is apparent. The incisors will assist in taking up, or even tearing off, leaves, which are then partially crushed between the undulated surfaces of the molars.

The skeleton consists of a cartilaginous basis, in the form of a long tapering chord for the body and tail, and in that of a capsule for the head. No segmentation into separate vertebræ is visible in any part of the notochord but it supports a considerable number of apophyses, the abdominal of which bear well developed ribs, all being solid cartilaginous rods, with a thin sheath of bone. In the same manner no part of the brain-capsule is ossified, but it is nearly entirely enclosed in thin bony lamellæ. This is also the structure of the appendages of the skull, as the mandible and the hyoid and scapulary arches. From a study of the skull, it becomes apparent at once why in fossil teeth of *Ceratodus* nothing or very little of the bone attached to them has been preserved. Those teeth rest on cartilage as well as on bone, the latter being a very thin and porous layer which could not be preserved, unless the progress of stratification had been going on with as little disturbance as in the Solenhofen Schiefers; but the matrix in which fossil Ceratodont teeth are found shows that it was formed under very different conditions, and it is certainly not of a nature to permit the supposition that thin porous lamellæ of bone would have been preserved entire.

The structure of the skeleton reminds us much of that of the sturgeons, Chimæra, and especially of *Lepidosiren;* and of all the modifications by which it differs from these types, perhaps none is of greater interest than that observed in the paddles. The central part of the paddle, which we have found externally to be covered with scales, is supported by a jointed axis of cartilage extending from the root to the extremity of the paddle; each joint bears a pair of three- or two- or one-jointed branches. This is the case in the hind as well as fore-paddles, and we are justified in supposing that those extinct Ganoids of which impressions of paddles with scaly centres have been preserved, were provided with a similar internal skeleton. Professor Huxley, some years ago, drew attention to the analogy existing between the filamentary limbs of *Lepidosiren* and the lobate fins of certain extinct Ganoids, and the correctness of this view is fully borne out by the discovery of *Ceratodus*, inasmuch as the *Lepidosiren*-limb proves to be typically the same as that of *Ceratodus*, but reduced to the jointed central axis.

The gills are perfectly developed, four on each side. They are broad lamellated membranes, free from each other, but attached to the outer walls of the gill-cavity. One can hardly doubt that, in water of normal composition, they are sufficient for the purpose of breathing. A lung, however, is superadded to them, a true lung, which receives blood from a branch of the aorta, and returns it directly to the heart by a separate vein. Whilst the Barramunda is in water sufficiently pure to yield the necessary supply of oxygen, the function of breathing rests with the gills alone, and the lung receives arterial blood, returning venous blood, like all the other organs of the body; under this condition it does not differ from the air-bladder of other fishes. But when the fish is compelled to sojourn in thick muddy water, charged with noxious gases, which must be the case very frequently during the droughts which annually exhaust the creeks of tropical Australia, it commences to breathe air in the way indicated above; under this condition the pulmonary vein carries purely arterial blood to the heart, where it is mixed with venous blood and distributed to the various organs of the body. If the medium in which the fish happens to be is perfectly unfit for breathing, the gills cease to have any function; if only in a less degree, the gills may still continue to assist in respiration. In short, the organisation of the Barramunda is such as to justify us in the assertion that it can breathe by either gills or lung alone, or by both simultaneously.

With regard to the structure of the lung, it shows a nearer approach to the air-bladder of other living Ganoid fishes than that of *Lepidosiren;* it is not paired, but consists of a single long sac extending nearly to the end of the abdominal cavity. Yet the interior of the sac shows a symmetrical arrangement of the right and left side, being subdivided into numerous cellular compartments, by which the respiratory surface is much increased in extent.

The next organ of importance for determining the systematic affinities of the Barramunda is the heart. Considering the great resemblance this fish has shown in other respects to *Lepidosiren*, I fully expected to find this organ agree also with the Dipnoous type; but this is not the case. Instead of the two longitudinal valves of the Dipnoous heart, the *bulbus arteriosus* is provided with two or three transverse series, of which one only is fully developed; or, in other words, *Ceratodus* proved to be a Ganoid fish. But, as *Ceratodus* and *Lepidosiren* are in all other points too closely allied to be separated in two distinct sub-classes or even sub-orders, we must arrive at the conclusion to drop the *Dipnoi* as a sub-class, and to refer *Lepidosiren* also to the Ganoids, which will then be characterised, not by transverse series of valves, but by the presence of a muscular, contractile *bulbus arteriosus* with valves, transverse or longitudinal, in its interior—a structure which they have in common with the sharks and rays (*Plagiostomata*).

The intestinal tract is a large straight sac with an internal spiral valve, as in the Ganoids and Plagiostomes. The kidneys are paired, the ureters enter a very small urine-bladder or cloaca at the back of, and partly confluent with, the rectum.

The organs of propagation show some noteworthy peculiarities. They are paired, in long bands. The male organs have no visible outlet, although a seminiferous duct has been found traversing the substance of the testicle through nearly its whole length; no outward opening could be discovered, and it is not known how the semen is discharged. The ova are small, very numerous, and attached to transverse laminæ of the ovaries; when mature, they fall into the abdominal cavity, as in the salmon tribe, and would appear to be expelled through two wide slits behind the vent. Yet each ovary is accompanied by a long oviduct, as in the sturgeon or *Lepidosiren*, though it probably has no function, and is only indicative of an approximation of this remarkable fish to higher types. Such are some of the principle features of the organisation of the Barramunda; and it remains now to add some remarks on its affinities and its place in the system.

A. GÜNTHER

(*To be continued.*)

ON EXOGENOUS STRUCTURES AMONGST THE STEMS OF THE COAL-MEASURES

IN a memoir recently read before the Royal Society, I propounded a new classification of the vascular cryptogams, and at the late meeting of the British Association at Edinburgh I brought the same subject forward, when my views were opposed by Mr. Carruthers, Dr. M'Nab, and Prof. Dyer, as reported in the columns of NATURE for Aug. 31. I was well aware that when I disturbed existing and time-honoured systems of classification I should meet with such opposition; but, being thoroughly convinced that my views are sound, and that they will ultimately be adopted, it only remains for me to face the conflict, and persevere with my demonstrations of what I believe to be true. My present object is to do what was impossible in the hurried and unsatisfactory discussions that frequently arose at the meetings of the British Association to accomplish, viz.: to take care that there shall be no misunderstanding as to the real points at issue. My opponents seek to interpret the gigantic arborescent stems of the coal-measures by the light of the dwarfed and degraded examples of vascular cryptogams which constitute their living representatives. I, on the other hand, claim to interpret the latter by the former, some of which, the Lycopods, for example, instead of being feeble things trailing in the grass, had stems three feet in diameter, and rising a hundred feet into the air Instead of merely constituting a verdant carpet for forests of noble exogens and endogens, they were the forest; here, consequently, we might expect that whatever characteristic features they possessed would be developed and displayed in their utmost perfection.

Mr. Carruthers' fundamental argument is, that I, in my classification, elevate the vegetative organs at the cost of the reproductive ones. I reply I am merely applying principles already adopted by botanists throughout the world. They are those of DeCandolle, of Endlicher, of Lindley, of Brongniart, and of Balfour. These writers, in common with most others, recognise primary distinctions that are purely vegetative. Not only are those which separate vascular from cellular plants of this character, but the further ones of exogens, endogens, acrogens, and thallogens are of the same nature. The fact of the closest resemblance of the inflorescence, and of the formation of the embryo in the embryo-sac in the two groups, does not prevent the separation of the flowering plants into exogens and endogens. Turning from the phanerogamous to the cryptogamic plants, we find that nearly every writer of importance adopts vegetative features as the basis of his classification. DeCandolle divides his *Acrogens* into those which have and those which have not vascular tissues. Endlicher's primary term *Cormaphyta* refers to a vegetative feature, viz., the possession of a stem, whilst his secondary divisions of *Acrobrya*, *Amphibrya*, and *Acramphibrya* all refer to the mode of growth and not to fructification. Lindley again distinguishes his flowerless plants according as they are acrogens or thallogens; whilst Balfour characterises them primarily as acrogens or cormogens and thallogens. In thus dwelling upon the vegetative element of the cryptogams, I am merely treading in the steps of nearly every writer of note who has written on these subjects. So much, therefore, for the primary point.

In many of the discussions which have taken place, my opponents have made the mistake of supposing that I was trying to prove these fossil coal-plants to be dicotyledonous exogens. Whereas what I have throughout contended for is that they are true cryptogams with an exogenous woody axis. Mr. Carruthers says, "The plants were true cryptogams, and in their organisation agree in every essential point with the stems of Lycopodiaceæ" (NATURE, p. 337). With this I of course agree, but I contend that we must interpret the lower forms by the higher and not the higher by the lower. In Carboniferous ages, these plants became superb forest trees, and consequently their stems attained their full development, growing year after year, from their almost microscopic condition when they burst from a microscopic spore, until they became stately trees, such as were revealed at Dixon Fold, and such as are illustrated by specimens now in the Manchester Museum. In the course of their magnificent development the stems were gradually fitted to sustain an enormous weight of branch and foliage. This was done by the development, within those stems, of a vascular woody cylinder, which grew thicker year by year; *such thickening being the result of additions to the exterior of the previous growths.* We here come to a definite issue. Do my opponents intend to deny the existence, in these arborescent carboniferous plants, of these thick ligneous cylinders, or to dispute that they grew in the way described? I think they cannot possibly contemplate doing so. Dr. M'Nab says botanists are agreed in this, that "Lepidodendra and their allies are closely related to other Lycopods. Now we know that the Lycopods, *like the Ferns, have closed fibro-vascular bundles; bundles which can only grow for a certain time, and then, all the cambium being converted into permanent tissue, growth must cease.*" The italics in the preceding paragraph are my own. With the above remark, so far as Ferns are concerned, I thoroughly agree. The facts so correctly stated by Dr. M'Nab constitute one of the fundamental bases of my proposed classification. The vascular bundles *are* closed in all the small ferns, and they remain equally so in the Cyatheas and other arborescent ferns which attain to stately dimensions. The development of this type into a lofty tree has not materially modified the structure of the stem which recurs in the most dwarfed species. But when Dr. M'Nab applies the above general statement to the Lycopods, facts do not sustain him. The huge lepidodendroid carboniferous plants give it a direct contradiction. They have *not* closed vascular bundles, and their growth did *not* cease after a limited time, but was obviously continued, being sustained by a cambium layer, until the plants assumed the magnificent dimensions which their fossil remains now exhibit. That the large vascular cylinder of the fossil forms is a development of what is seen, not only in *Lycopodium chamæcyparinus* referred to by Dr. M'Nab, but in every one of the numerous Lycopods of which I have examined sections, I have never denied. Quite the contrary. But I repeat we must interpret the significance of the *least* developed form by that which is *most* developed. Consequently we must regard the irregular vascular bundles which exist, commingled with cellular tissues, in the axis of each living Lycopod, as a degraded wood cylinder, whose nature can only be understood by reference to what it once was when its parent tree was one of the glories of the primæval forest. The race as a whole has become degenerate, and the stem being no longer called upon to sustain a lofty superstructure, its structure has become equally degenerate.

I will not enter in detail into the question of the nomenclature of the various parts of these exogenous cryptogamic stems, but reserve that subject for some other occasion, after my detailed memoirs now in the hands of the Royal Society have been published. I will merely express my conviction that Mr. Carruthers, who differs widely from me on the subject, assumes the very question in debate between us.

He holds that we can draw no parallel between the conditions existing in the stems of Cryptogams and those of Phanerogams. This is precisely what I contend we can do, and I trust to be able, as my self-appointed task proceeds to its conclusion, to demonstrate to the botanical world that I have abundant reason for so doing. This is a question wholly resting upon facts, and until those facts are fairly before the world, I object to the adoption of any *a priori* conclusion on the subject. Consistently with his views Mr. Carruthers objects to my applying to the stems in question such terms as medulla and medullary rays; especially objecting to the application of the term medulla to a structure containing vessels, *i.e.*, a vascular medulla; but Nepenthes has a vascular medulla, as well as some other phanerogamous plants, and no one presumes to deny the medullary character of such a tissue, because it happens to have vessels in it. The medullary character of the structure does not rest upon the basis of its being wholly devoid of vessels, neither does their occasional presence militate against its being a medulla.

In the preceding remarks I have confined myself substantially to the task of making clear the points at issue between my opponents and myself. In adopting my views of the exogenous structure of the stems in question, I am but following in the steps of some of the ablest of living botanists. M. Adolphe Brongniart, than whom no higher authority can be named, not only adopts the exogenous theory, but is so deeply impressed with its force that he denies the probability of many of the plants in question having been cryptogamic. He places them amongst the gymnospermous exogens. Recent events, however, have shown that though exogenous they are true cryptogams. How absurd, then, to apply to such stems the term acrogen or acrobrya! This controversy must be ultimately settled by the logic of facts, not by vague opinions, and to these I confidently appeal. The details of my proposed classification can only be discussed when all the facts are before the public. When this is the case, I hope to show that my proposition not only does no violence to the true affinities of living cryptogams, but that, in bringing the ancient and modern types into a philosophical relationship, it accomplishes what, under existing systems of classification, it is impossible to do.

W. C. WILLIAMSON

METEOROLOGY IN AMERICA *

II.—ORGANISATION OF THE UNITED STATES SIGNAL SERVICE.

THERE are probably few departments of the Executive of the United States which have been of such essential practical value as the Signal Service; and among those who have been instrumental in establishing it, we cannot avoid mentioning the names of the Hon. Halbert E. Paine of Wisconsin, the Hon. Henry L. Dawes of Massachusetts, and the Hon. William W. Belknap, Secretary of War.

It may be added that, without distinction of party, the whole people of the country, the press, both Houses of Congress, and the President, have earnestly sustained and advanced this important branch of the public service.

The military system is one of the most valuable features in the constitution of this Signal Service for the benefit of Commerce. The advantages of having the whole corps of weather observers in the army are manifest and manifold. Each observer feels the responsibility of a sentinel at his post, which begets in him a sentiment of devotion to duty the strongest of which men are capable, and which has often led the soldier to imitate the example of the Roman guard at Pompeii, who, after nearly eighteen centuries, was taken from its ruins in his martial position, showing that he had not fled before the molten flood from Vesuvius. Experience has proved what the sense of the Government originally suggested, that observations would be most punctually and scrupulously taken at the different stations by men accustomed to the discipline and obedience, even in minutest details, of army subalterns.

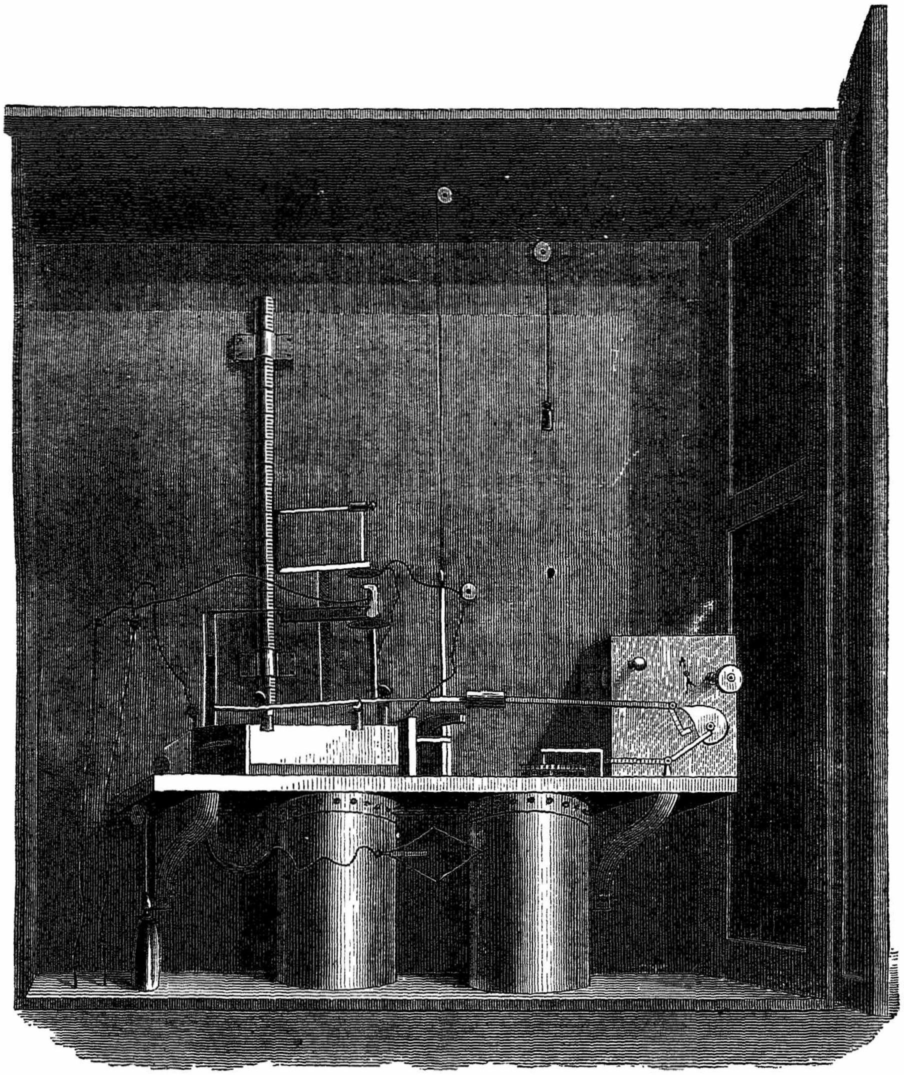

FIG. 4—PROF. HOUGH'S NEW PRINTING BAROMETER

They are required to work out no difficult problems in meteorology, but simply to observe and record the indications of their instruments, and to transmit the same without delay or inaccuracy. In doing this work, they have become by tri-daily practice as expert and exact in reading the glasses as any of our veteran scientific men—indeed, as much so as a Fitzroy or a Leverrier could be.

Regarding the Signal Corps scattered through and over all parts of the country, we may compare it to a regiment on drill three times a day, the telegraph instantly revealing to the commanding officer, General Albert J. Myer, at Washington, the slightest failure in any observer.

By this now widely spread and magnificently organised system, the United States army, engaged under the chief

* We are again indebted to *Harper's Weekly* for the continuation of the article by Prof. Maury, and the woodcuts which we reproduce this week.

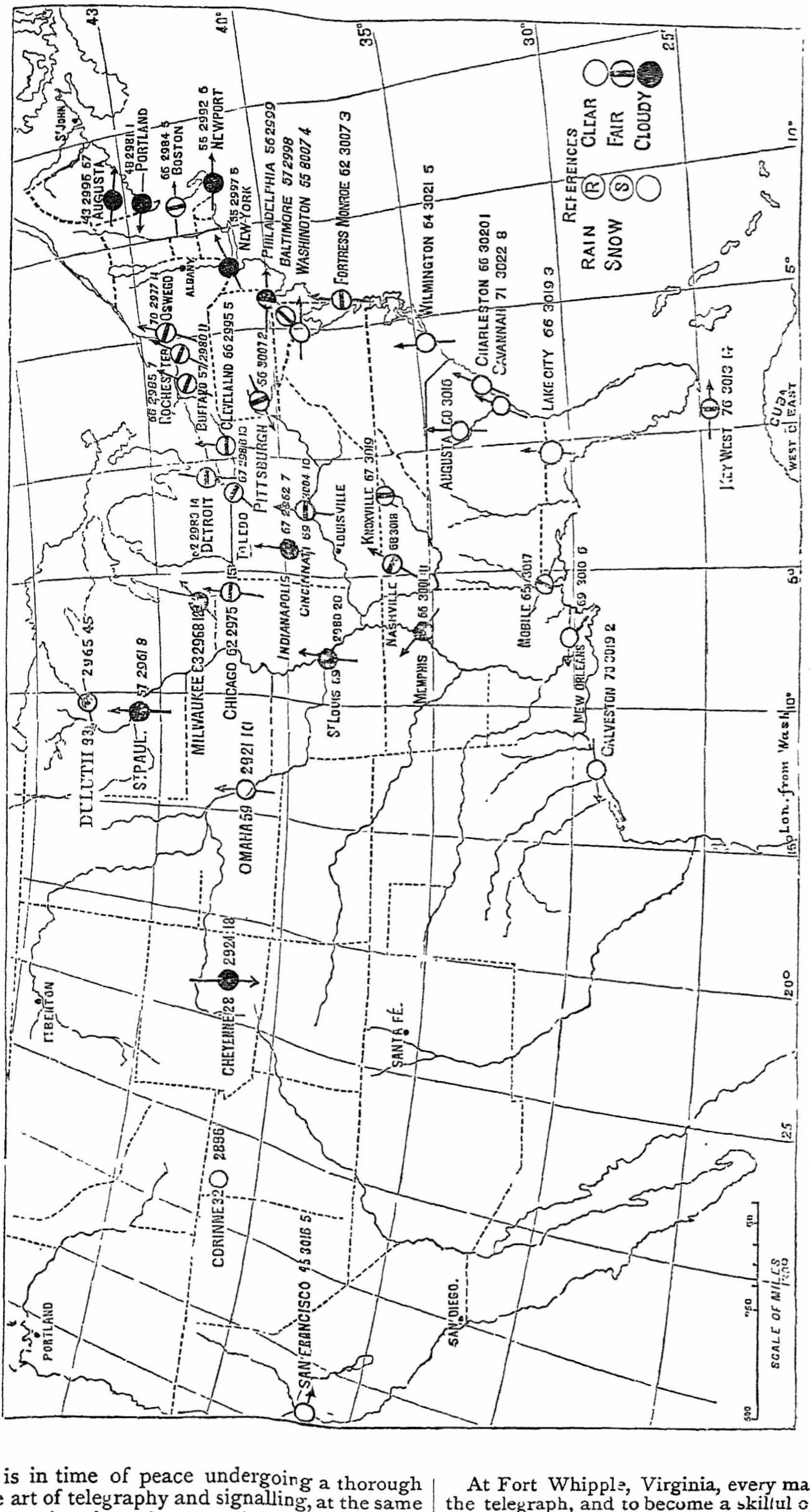

FIG. 5.—WAR DEPARTMENT WEATHER MAP (SIGNAL SERVICE, U.S.A.), SATURDAY, APRIL 8, 1871, 7 35 A.M., WASHINGTON

The Numerals denote: 1st, the State of the Thermometer; 2nd, that of the Barometer; and, 3rd, the Force of the Wind.

signal officer, is in time of peace undergoing a thorough training in the art of telegraphy and signalling, at the same time that it is passing through a most thorough discipline, is being educated to science, and also serving one of the most important ends ever devised for the benefit of commerce.

At Fort Whipple, Virginia, every man is taught to use the telegraph, and to become a skilful operator. He thus has a profession at all times lucrative to himself wherever he may be afterwards thrown. The training, skill, and habits of exactness acquired by the Signal Corps in time of peace will be of the greatest value to the army in time of war. The telegraph is capable of indefinite utilisation. General Von Moltke, it is well known, conducted the late operations of the German army on the battle-fields of France sitting in the rear with his map before him, and his telegraphic operator at his side, keeping him in communication with all parts of the field. It has been frequently said by distinguished military men that the telegraph will be one of the most effective weapons in any war that may now occur How necessary for the Government to keep up the efficiency of such a corps as that of which we have spoken!

As the organisation under General Myer now exists, the President and Secretary of War have a responsible military man at every important post in the country. If a warlike expedition appears on any part of our coast, causing a panic or stampede, there may be a thousand wild rumours of frightened message-senders. The Government, however, is in the receipt every eight hours (and can be in the receipt every hour if it wishes) of a reliable

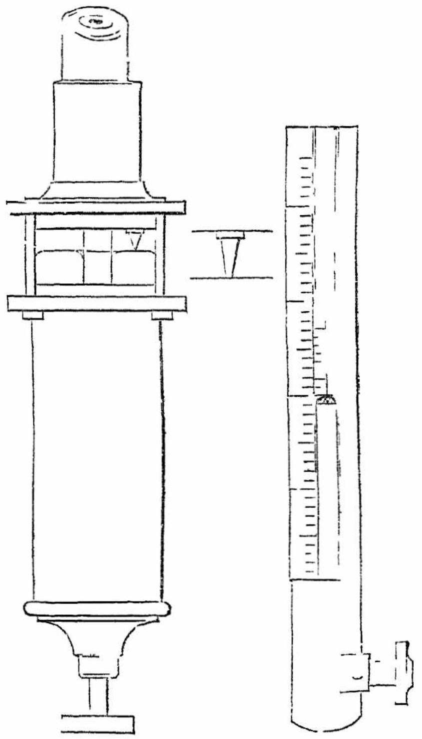

FIG. 6.—SECTION OF GREEN'S STANDARD BAROMETER

message from its own agent, who reports on his responsibility what he saw and knows to be true; and this observer will not leave his post until ordered to do so. As a mere Government police, therefore, the Signal Corps would be worth to the nation far more than it can ever cost, even if its operations should be more widely extended, as will speedily be done.

Each sergeant is sent to the Signal Service school for instruction at Fort Whipple, Virginia, where he is immediately supplied with Loomis's "Text-book of Meteorology," Buchan's "Hand-book of Meteorology," Pope's "Practical Telegraphy," and the "Manual of Signals for the United States Army," together with all the instruments necessary for practical instruction. The books he must thoroughly master. He is required to cite once daily didactically, and to practise a certain time with the instruments. He is required to remain under tuition until considered by the instructor competent to take charge of a station and perform the necessary duties, when he is ordered before a board, consisting of three army officers, for examination, when, if considered incompetent, he is returned to Fort Whipple for further instruction and practice.

If, after a rigid examination, he is found capable, he is assigned to a station, and the necessary stationery and instruments furnished him (the latter consisting of the barometer, thermometer, hygrometer, anemoscope, anemometer, and rain-gauge), and instructions to make three observations daily, viz., at the time corresponding with 7 35 A.M., 4.35 P.M., and 11.35 P.M. Washington time, so that every observer at each station should be reading his instruments at the same moment, and in the following order, viz, 1st, barometer; 2nd, thermometer; 3rd, hygrometer; 4th, anemoscope; 5th, anemometer; and 6th, rain gauge.

In addition to the duties discharged by the officers of the Examining Board, Colonel Mallery, A.S.O., has the general charge of the very large correspondence of the office; Captain Howgate has charge of the statistics and all observations of the service; and Lieutenant Capron has the difficult post of instructor of sergeants at Fort Whipple.

Where a single person has been required to do the work of a station, receiving full reports from all stations, the labour occupied twenty hours out of the twenty-four. But the rule now adopted is to provide each station with two men—one a sergeant in charge and the other a private soldier as assistant. The observer stationed on Mount Washington has been alone on the mountain most of the time, and always responsible for the work.

In addition to a number of officers who form the Board of Examination, General Myer is also ably assisted by Major L. B. Norton, the property and disbursing officer of the Signal Service.

Prof. Cleveland Abbé, long known as an officer of the Cincinnati Observatory, and as an eminent meteorologist, is employed chiefly in the work of making out the daily synopsis of the weather, and deducing therefrom the weather "probabilities," which are given to the public by telegram through all newspapers desirous of furnishing them to their readers.

To the conspicuous ability of all of these officers is attributable the success of the enterprise.

The ordinary barometer in use by Signal Office observers is that of Mr. James Green (the well-known scientific instrument maker of New York)—an instrument adopted by the Smithsonian Institution, and also by the American navy, as the most perfect to be obtained.

This barometer has its cistern furnished with a small glass index, which shows when the mercury is at the right height in the cistern. This is adjustable by a screw which works through the bottom of the instrument against the flexible bottom of the cistern. The instrument is ready for use when the mercury touches the little V-shaped index in the cistern. So simple and complete is this barometer that any one can use it, and it ought to be in the hands of all business gentlemen, and all who are interested in watching the mutations of the weather.

Latitude and longitude on the earth's surface mark very conspicuous differences in the mean barometrie pressure, as will be seen by a study of the Isobarometric Chart for the United States, which we gave last week.

The barometer has a slight fluctuation also under several influences. It rises when the moon is on the meridian in some places. It has a diurnal oscillation, amounting on the equator to more than one-tenth of an inch, but in the latitude of New York to only 0·05 inch, the greatest height being about ten A.M., and the least about four P.M. The nocturnal variations are much less. In the latitude of Philadelphia and New York the north-east wind causes another variation of one-fourth of an inch, due to the meeting of two atmospheric waves giving a still higher wave, and hence a higher barometer. There is also the variation due to the height of the observer's station above the sea. This is, of course, of the first importance. The other fluctuations are comparatively unimportant, and do not blind an observer to those ominous fluctuations which precede the storm, the tornado, and the hurricane. The oscillations which indicate a storm are very marked. The tornado which recently ravaged St. Louis was preceded by a gradual fall of the mercury in the barometer, for thirty hours previous, of an entire inch. At Boston, within thirty-seven years, the barometer has ranged from 31·125 inches to 28·47 inches, the difference being 2·655 inches. At London it has ranged through more than 3·5 inches; but in the tropics not so much.

During the passage of a cyclone the mercury oscillates rapidly. The most noticeable fall occurs from four to six hours before the passage of the storm centre. This fall is often over an inch, and sometimes two inches.

Great changes are usually shown by falls of barometer exceeding half an inch, and by differences of temperature exceeding fifteen degrees. If the fall equals one-tenth of an inch an hour we may look out for a heavy storm. The more sudden the change the greater the danger. But it is too often forgotten that the fall of the mercury is a forewarning of what will occur in a day or two, rather than in a few hours.

A variation of an inch is certain to be followed by a tornado or violent cyclone. In the tropics "the glass" has been known to show a fall of more than an inch and a half in one hour!

The following guides in predicting weather changes are selected from the "Barometer Manual" of the London Board of Trade, and are suggestive:

I. If the mercury standing at thirty inches rise gradually while the thermometer falls, and dampness becomes less, N.W., N., or N.E. wind; less wind or less snow and rain may be expected.

II. If a fall take place with a rising thermometer and increasing dampness, wind and rain may be expected from S.E., S., or S.W.; a fall in winter with a low thermometer foretells snow.

III. An impending N. wind before which the barometer often rises may be accompanied with rain, hail, or snow, and so forms an apparent exception to the above rules, for the barometer always rises with a north wind.

IV. The barometer being at 29½ inches, a rise foretells less wind or a change of it northward, or less wet But if at 29 inches a fast first rise precedes strong winds or squalls from N.W., N., or N.E., after which a gradual rise with falling thermometer, a S. or S.W. wind will follow, especially if the rise of the thermometer has been sudden.

V. A rapid barometric rise indicates unsettled, and a rapid fall stormy weather with rain or snow; while a steady barometer, with dryness, indicates continued fine weather.

VI. The greatest barometric depressions indicate gales from S.E., S., or S.W.; the greatest elevations foretell wind from N.W., N., or N.E., or calm weather.

VII. A sudden fall of the barometer, with a westerly wind, is sometimes followed with a violent storm from the N.W., N., or N.E.

VIII. If the wind veer to the S. during a gale from the E. to S.E., the barometer will continue to fall until the wind is near a marked change, when a lull may occur. The gale may afterward be renewed, perhaps suddenly and violently; and if the wind then veer to the N.W., N., or N.E., the barometer will rise and the thermometer fall.

IX. The maximum height of the barometer occurs during a north-east wind, and the minimum during one from the south-west; hence these points may be considered the poles of the wind. The range between these two heights depends on the direction of the wind, which causes, on an average, a change of half an inch; on the moisture of the air, which produces in extreme cases a change of half an inch; and on the strength of the wind, which may influence the barometer to the extent of two inches. These causes, separately or conjointly with the temperature, produce either steady or rapid barometric variations, according to their force.

PRESENT OPERATION OF THE SERVICE

Although the Signal Service is yet in its infancy, and must be patiently nursed and cherished by the people for some years before it can expect to do and discharge its full mission, under General Myer's indefatigable care and skilful management it has already achieved much good, and more than compensated the public for the expense of its establishment. Since it was instituted last summer, "the chief signal officer has," to quote the words of the *New York World*, "thoroughly organised and equipped a system which now embraces in its scientific grasp every part of the land from Sandy Hook to the Golden Gate of California, and from Key West to the Dominion of Canada."

Three times every day synchronous observations are taken and reports made from the stations—one at eight A.M., one at four P.M., and the third at midnight. These observations are made by instruments, all of which are perfectly adjusted to a standard at Washington. They are also all taken at the same moment exactly, these observations and reports being also timed by the standard of Washington time. The reports from the stations are transmitted in full by telegraph. By a combination of telegraphic circuits, the reports of observations made at different points synchronously are rapidly transmitted to the different cities at which they are to be published. They are, however, all sent of course to the central office in Washington. These reports are limited to a fixed number of words, and the time of their transmission is also a fixed number of seconds. These reports are not telegraphed in figures, but in words fully spelled out. There are now about forty-five stations for which provision has been made, and which are in running order. These have been chosen or located at points from which reports of observations will be most useful as indicating the general barometric pressure, or the approach and force of storms, and from which storm warnings, as the atmospheric indications arise, may be forwarded with greatest despatch to imperilled ports.

These stations are occupied by expert observers furnished with the best attainable instruments, which are every day becoming more perfect, and to which other instruments are being added.

The reports of observers are as yet limited to a simple statement of the readings of all their instruments, and of any meteorological facts existing at the station when their tri-daily report is telegraphed to the central office in Washington.

Each observer at the station writes his report on manifold paper.* One copy he preserves, another he gives to the telegraph operator, who telegraphs the contents to Washington. The preserved copy is a voucher for the report actually sent by the observer; and if the operator is careless and makes a mistake, he cannot lay the blame on the observer, who has a copy of his report, which must be a fac-simile of the one he has handed to the operator. The preserved copy is afterwards forwarded by the observer-sergeant to the office in Washington, where it is filed, and finally bound up in a volume for future reference.

When all the reports from the various stations have been received they are tabulated and handed to the officer (Prof. Abbé) whose duty it is to write out the synopses and deduce the "probabilities," which in a few minutes are to be telegraphed to the press all over the country.

* Thin paper with black carbon paper between the sheets. The pen is a dry *stylus*, and being pressed on the upper sheet, it makes a similar mark on the sheets beneath it.

This is a work of thirty minutes. The bulletin of "probabilities," which at present is all that is undertaken, is made out thrice daily, in the forenoon, afternoon, and after the midnight reports have been received, inspected, and studied out by the accomplished gentleman and able meteorologist who is at the head of this work.

The "probabilities" of the weather for the ensuing day, so soon as written out by the professor, are immediately telegraphed to all newspapers in the country which are willing to publish them for the benefit of their readers.

Copies of the telegrams of "probabilities" are also instantly sent to all boards of trade, chambers of commerce, merchants' exchanges, scientific societies, &c., and to conspicuous places, especially sea-ports, all over the country.

While the professor is preparing his bulletins from the reports just furnished him by telegraph, the sergeants are preparing maps which shall show by arrows and numbers exactly what was the meteorologic condition of the whole country when the last reports were sent in. These maps are printed in quantities, and give all the signal stations. A dozen copies are laid on the table with sheets of carbon paper between them, and arrow stamps strike in them (by the manifold process) the direction of the wind at each station. The other observations as to temperature, barometric pressure, &c., &c., are also in the same way put on them.

These maps are displayed at various conspicuous points in Washington—*e.g.*, at the War Department, Capitol, Observatory, Smithsonian Institution, and office of the chief signal officer. They serve also as perfect records of the weather for the day and hour indicated on them, and are bound up in a book for future use.

Every report and paper that reaches the Signal Office is carefully preserved on file, so that at the end of each year the office possesses a complete history of the meteorology of every day in the year, or nearly 50,000 observations, besides the countless and continuous records from all of its self-registering instruments.

When important storms are moving, observers send extra telegrams, which are despatched, received, acted upon, filed, &c., precisely as are the tri-daily reports. One invaluable feature of the system as now organised by General Myer is that the phenomena of any particular storm are not studied some days or weeks after the occurrence, but while the subject is fresh in mind. To the study of every such storm, and of all the "probabilities" issued from the office, the chief signal officer gives his personal and unremitting attention. As the observations are made at so many stations, and forwarded every eight hours, or oftener, by special telegram from all quarters of the country, the movements and behaviour of every decided storm can be precisely noted; and the terrible meteor can be tracked and "raced down" in a very few hours or minutes. A beautiful instance of this occurred on the 22nd of February last, just after the great storm which had fallen upon San Francisco. While it was still revolving around that city, its probable arrival at Corinne, Utah, was telegraphed there, and also at Cheyenne. Thousands of miles from its roar, the officers at the Signal Office in Washington indicated its track, velocity, and force. In twenty-four hours, as they had forewarned Cheyenne and Omaha, it reached those cities. Chicago was warned twenty hours or more before it came. Its arrival there was with great violence, unroofing houses and causing much destruction. Its course was telegraphed to Cleveland and Buffalo, which, a day afterwards, it duly visited. The president of the Pacific Railroad has not more perfectly under his eye and control the train that left San Francisco to-day than General Myer had the storm just described.

While the observers now in the field are perfecting themselves in their work, the chief signal officer is training other sergeants at the camp of instruction (Fort Whipple, Virginia), who will go forth hereafter as valued auxiliaries. It has been fully demonstrated by the signal officer that the army of the United States is the best medium through which to conduct most efficiently and economically the operations of the Storm Signal Service. Through the army organisation the vast system of telegraphy for meteorological purposes can be, and is now being, most successfully handled. "Whatever else General Myer has not done," says the *New York World*, "he has demonstrated that there can be, and now is, a perfect network of telegraphic communication extending over the whole country, working in perfect order, by the signalmen, and capable of furnishing almost instantaneous messages from every point to the central office at Washington. Think of a single jump by wire from San Francisco 2,700 miles eastward three times a day! When General Myer undertook to put this system in working order, the telegraph companies said it was impossible—no such thing had ever been heard of in telegraphing. It is now a grand *fait accompli*, as much as the passing of the Suez Canal by ships or the escaping from Paris by balloons." *

At present the signal officer aims only to give a synopsis of each day's weather, and a statement of what weather may be expected or will probably occur. The "probabilities" so far have been most beautifully verified and confirmed.

It is not thought wise to undertake more than can be securely accomplished. The synopses and "probabilities" are all that intelligent shippers and careful seamen require. Shippers will not send their vessels to sea if the weather synopsis indicates threatening or alarming weather.

Travellers can consult the "probabilities" before leaving home; and any severe storm that menaces any city or port is now specially telegraphed thither, and the announcement is made by bulletins posted in the most public places.

By the modest estimate of the signal officers, the following is a table showing percentage of "probabilities" that have been verified:

Fully verified	50 per cent.
Verified in part . . .	25 ,,
Failed	25 ,,

It must, however, be borne in mind that the failures have often been due to lack of information from points where as yet no observer-sergeant is stationed.

FUTURE AIMS

The Signal Service has, up to this time, acted upon the wise maxim of "making haste slowly," and undertaking to do nothing which was not in its power to do safely and securely without risk of failure. It has acted upon the confidence it has in the people that they will patiently await the development of solid science, meantime leaving no stone unturned to hasten forward the observations which may lead to a more exact acquaintance with the habits, movements, and tracks of our American storms. Great progress has in a very short time been made in this knowledge, and every day new light is dawning upon the science of storms.

The instruments of the service have been bought on trial. They are undergoing the most varied experiments. In a short time, it is hoped, they will be greatly improved and perfected, and then the chief signal officer's results will be more satisfactory to himself, and his labours will be greatly facilitated. The celerity with which important results have already been attained by this officer has surprised and startled both himself and the friends of the great movement.

As soon as possible, therefore, the Signal Office will have its signal posts along the lakes and on our Atlantic sea-board, where cautionary signals will be displayed, warning vessels of approaching gales and storms, and

* *New York World*, March 5, 1871.

also a signal for clear weather. These will be displayed by day and by night by a very simple and suitable contrivance now being perfected by General Myer. In New York already arrangements have been made for displaying the signals to shipping in the harbour from a lofty structure on the roof of the Equitable Life Insurance Company's office, the best station that could be chosen. The display of these storm signals proper will place the American Signal Bureau at once in a position to render inestimable service to shipping and all commercial interests.

These signals will at first be neglected by ruder and more unskilful seamen and shippers ; but, as in the case of the famous Fitzroy signals on the English coast, every week will add new demonstrations of the value and utility of this system—one of the most splendid gifts bequeathed by modern science to the human race.

The signalling of storms and desolating cyclones to the unsuspecting seaman will, it is believed, mark a new era in our lake and coast navigation, and be the means of annually saving many lives and millions of dollars' worth of our floating property.

The comparison of these signals with the weather following the signals will be then a matter of special attention. Every discrepancy can then be carefully noted and probed, and every day the meteorologists in charge of the "probabilities" will find the means of rectifying any errors they may have fallen into, and daily increasing the accuracy and perfecting the plan of their forecasts.

The storm signals will be displayed at any hour of the day or night when the instrumental indications give notice of bad weather ; and experience has already shown that generally at least twenty-four hours' forewarning can be given from the central office in Washington of all important weather phenomena. With the telegraph to premonish, forecasts for two or three days in advance are hazardous and unnecessary. For almost all practical purposes of life a day's notice of atmospheric disturbances is quite sufficient, and more reliable than longer premonitions. It will be a grand triumph for American science when the electric telegraph is so utilised that it will bring all citizens of the United States into electric communication with each other, and the most fearful storm, as well as the sunshine and shower, shall be every day a subject of forewarning or congratulation throughout the land, and even on the lakes and oceans that wash the American coasts.

OPENING OF THE MONT CENIS TUNNEL

THE project of constructing a tunnel under the Alps —one of the favourite designs of that ardent patriot and eminent statesman, the late Count Cavour—has now been accomplished, thanks to the skill of the Italian engineers. The scientific requirements and methods adopted are well stated in a recent article in the *Daily News*, to which we are indebted for the following interesting particulars :—

The tunnel was commenced on the 15th of August, 1857. The two points at which it was determined to begin the boring were two wretched little Alpine villages, Bardonnecchia and Fourneaux, the former on the Italian, the latter on the French side of Mont Fréjus, the tunnel being nearly pierced under the above-named mountain, and not, as common report would have it, beneath Mont Cenis. These two villages were of the smallest size and most miserable character, and offered no accommodation whatever to the many hundred workmen employed on either side the mountain. Bardonnecchia, on the Piedmontese side, is a village which, in 1857, when the works commenced, contained about 1,000 souls. The houses in it were really little better than huts, being mostly occupied by shepherds, who were absent with their flocks on the mountains during the summer months. At Fourneaux things were even worse, there being an ordinary population of only 400 inhabitants.

The first problem to be solved, says Mr. Fras. Kossuth, one of the Royal Commissioners of Italian Railways, in his able report on the Mont Cenis Tunnel, was threefold. (1) To fix across the mountain several points which would all be contained in the vertical plane drawn through the axis of the tunnel. (2) To obtain the exact length between the openings. (3). To know the precise difference of level between the two extremities of the tunnel, so as to obtain the proper gradients. In order to execute this programme, a series of observations was established on all the favourable points, and an elaborate trigonometrical survey of the district was commenced. By the end of the season little could be done in the way of surveying; in the winter of the year 1858 all the surveys relating to the alignment and to the length of the tunnel were completed, and all was ready to compile the longitudinal section along the axis of the tunnel. The whole system consisted of twenty-eight triangles, and eighty-six was the number of measured angles. All of these were repeated never less than ten times, the greater part twenty, and the most important as many as sixty times. To give the reader an idea of the extraordinary care and accuracy with which the surveying operations were carried out, it may be mentioned that Signor Mondino repeated his experiments for obtaining the level of the tunnel, or rather of the signals over the mountain in 1857 and 1858, and the difference in the two surveys (over more than 13,000 yards), was only 3·93 inches. Even this was reduced afterwards by Signor Termine to 1·57 inch. The preliminary measurements gave a distance of 13,861·5 yards between the two temporary openings We say temporary openings, because, although the tunnel is itself constructed in a perfectly straight line from Fourneaux to Bardonnecchia, passengers will not pass through the original straight tunnel, but will be conveyed through a branch one which joins the main line a short distance from Fourneaux. The nature of the ground was such as to necessitate the definite and permanent tunnel being taken through the mountain in a curve ; but even the unprofessional reader will see that a straight line was indispensable, in order to secure not only accuracy of direction, but also a through draught of air through the whole length of the tunnel. A most important consideration this latter, as one of the main objections brought against the scheme was the supposed difficulty there would be in keeping the tunnel thoroughly well ventilated. It was also much easier to transmit the necessary motive power along a straight line than on a curve. The tunnel, although its axis was straight, was not constructed on a dead level. The gradients were : From the Bardonnecchia (Italian) end, 4,408·50 feet above the level of the sea, 1 in 2,000 (0002 per metre) for a distance of 20,997·33 feet. From the Fourneaux entrance (French side), 3 945 feet above the sea, the rising gradient was 1 in 43 4782 (·023 per metre) for 20,587 feet.

The absolute figures are as follows :

Total length of the tunnel, 13,364 86 yards.

Elevation above the sea-level of the Bardonnecchia entrance	4,381·25
Rise of gradient of 1 in 2,000 for 20,048 feet . .	10·024
Summit level from Bardonnecchia	4,391·274
Elevation above sea-level at Fourneaux entrance .	3,946·50
Rise of gradient of 1 in 45,045 for 200,045·10 feet.	445·00
Summit level from Fourneaux .	4,391·50

This shows a very slight difference from the calculations of the summit level as reckoned at Bardonnecchia, and gives a mean level for the highest point of 4,391·386 feet. The greatest height of the mass of the Alps over the tunnel is 5,307 feet.

After giving these figures, it may be of interest to present the reader with the account given by an eye-witness, M. Génési, of the meeting of the workmen last winter in the depths of the earth, more than 5,000 feet beneath the summit of Mont Fréjus. "On the 9th of November, 1871," says M. Génési, "I was on my regular round of inspection as usual, when I fancied I heard through the rocks the noise of the explosion of the mines on the Bardonnechia side. I sent a dispatch to discover if the hours agreed. They did, and then there could be no longer any doubt we were nearing the goal. Each following day the explosions were to be heard more and more distinctly. At the beginning of December we heard quite clearly the blows of the perforators against the rocks. Then we vaguely heard the sound of voices. But were we going to meet at the same level and in the same axis? For three days and three nights engineers, foremen, and heads of gangs never left the tunnel. The engineers Borelly and Boni directed the works on the Bardonnechia side, M. Copello on that of Fourneaux. We could not eat or sleep; every one was in a state of fever. At length, on the morning of the 26th December, the rock fell in near the roof. The breach was made, and we could see each other and shake hands. The same evening the hole was clear—the last obstacle—and the mountain was pierced, our work was done. What a rejoicing we had! In spite of the war, the cheers of all scientific Europe came to find us in the entrails of our mountain when the happy termination of our enterprise became known. The two axes met almost exactly; there was barely half a yard error. The level on our side was only 60 centimetres (less than three-quarters of a yard) too high. But after thirteen years of continual work, who could even hope for so perfect a result? We placed at the point of junction an inscription on a marble tablet, commemorative of the happy event."

How was the happy event brought about? For the variation of less than a yard in more than 13,000 is surely one of the triumphs of modern engineering skill. We cannot do better than borrow the description of the method pursued given by Mr. Kossuth:—"The observatories placed at the two entrances to the tunnel were used for the necessary observations, and each observatory contained an instrument constructed for the purpose. This instrument was placed on a pedestal of masonry, the top of which was covered with a horizontal slab of marble, having engraved upon its surface two intersecting lines marking a point, which was exactly in the vertical plane containing the axis of the tunnel. The instrument was formed of two supports fixed on a tripod, having a delicate screw adjustment. The telescope was similar to that of a theodolite, provided with cross webs and strongly illuminated by the light from a lantern, concentrated by a lens, and projected upon the cross webs. In using this instrument in checking the axis of the gallery at the northern entrance, for example, after having proved precisely that the vertical flame, corresponding with the point of intersection of the lines upon the slab, also passed through the centre of the instrument, a visual line was then conveyed to the station at Lachalle (on the mountain), and on the instrument being lowered the required number of points could be fixed in the axis of the tunnel. In executing such an operation it was necessary that the tunnel should be free from smoke or vapour. The point of collimation was a plummet suspended from the roof of the tunnel by means of an iron rectangular frame, in one side of which a number of notches were cut, and the plummet was shifted from notch to notch, in accordance with the signals of the operator at the observatory. These signals were given to the man whose business it was to adjust the plummet by means of a telegraph or a horn. The former was found invaluable throughout all these operations. At the Bardonnecchia entrance the instrument employed in setting out the axis of the tunnel was similar to the one already described, with the exception that it was mounted on a little carriage, resting on vertical columns that were erected at distances 500 metres apart in the axis of the tunnel. By the help of the carriage the theodolite was first placed on the centre line approximately. It was then brought exactly into line by a fine adjustment screw, which moved the eye-piece without shifting the carriage. In order to understand more clearly the method of operating the instrument, the mode of proceeding may be described. In setting out a prolongation of the centre line of the tunnel, the instrument was placed upon the last column but one; a light was stationed upon the last column, and exactly in its centre, and 500 metres ahead a trestle frame was placed across the tunnel. Upon the horizontal bar of this trestle several notches were cut, against which a light was placed and fixed with proper adjusting screws. The observer standing at the instrument caused the light to move upon the trestle frame until it was brought into an exact line with the instrument and the first light, and then the centre of the light was projected with a plummet. In this way the exact centre was found. By a repetition of similar operations the vertical plane containing the axis of the tunnel was laid out by a series of plummet lines. During the intervals that elapsed between consecutive operations with the instruments, the plummets were found to be sufficient for maintaining the direction in making the excavation. To maintain the proper gradients in the tunnel it was necessary at intervals to establish fixed levels, deducing them by direct levelling from standard bench marks placed at short distances from the entrances. The fixed level marks in the inside of the tunnel are made upon stone pillars placed at intervals of 25 metres, and to these were referred the various points in setting out the gradients."

There will be two lines of rail in the tunnel. The vault itself will be six metres high and eight metres wide. The tunnel will be walled in along its whole length, and the lime rock will be nowhere exposed. The thickness of the internal masonry forming the tube is from half a yard to a yard and more, according to circumstances. On the French side the masonry cost on the average 1,300 francs the square metre. On the Italian side only 1,000 francs. The tunnel is wonderfully dry in comparison with many smaller works. There is only one subterranean spring of any importance in it. A water-course, or rather aqueduct, has been constructed beneath the permanent way, in order to carry off any water which might drain into the tunnel.

Much has been said about the heat in the tunnel. All accounts agree that it is not excessive, and a recent French visitor to the tunnel gives the following figures:—At the entrance, 54° Fahrenheit; at the telegraph station inside, 76° Fahrenheit; the average temperature being about 65° Fahrenheit.

NOTES

The first session of the Newcastle-on-Tyne College of Physical Science will be opened by inaugural addresses from Professors Herschel, Aldis, Page, and Marreco, from the 9th to the 12th of October. The examination for the four exhibitions will be held on the 13th and 14th. On the 19th the Inaugural Ceremony will take place, when the Dean of Durham will deliver an address; after which the successful candidates for the exhibitions will be named. Further particulars are given in our advertising columns.

We announced some time ago that the Council of the Working Men's College, in Great Ormond Street, was proposing a larger infusion of Science in the programme of the College course; and we are now very glad to be able to state that during the next term, which will commence on October 2, courses of lectures will be given on Geology, by Mr. J. Logan Lobley; on the Use of the Microscope, by Mr. J. Slade; and on Physiology, by Mr. J. Beswick Perrin. Students entering for the course on Geology will have the privilege of attending the ordinary and field meetings of the Geologists' Association. Among the Saturday General Lectures one will be delivered by Prof. W. H. Flower, of the Royal College of Surgeons. No more useful work could be performed than that so generously offered by these gentlemen, who give up their time to the scientific instruction of the working classes in London. We venture at least to predict that they will be rewarded by intelligent and appreciative audiences.

DR. ALLEYNE NICHOLSON, late Lecturer on Natural History in the Medical School of Edinburgh, has been appointed to the Chair of Natural History in the University of Toronto.

A SPECIAL prize was established a few years ago by the French Academy, for the best translation delivered to that body. This prize was awarded in the sitting of the 17th of August to the author of a translation of Mr. Grote's "History of Greece," published by Lacroix. Mr. Grote was an associate member of the Académie des Sciences Morales et Politiques.

LETTERS from Switzerland state that M. Gerlach, a distinguished Swiss engineer and geologist, was fatally injured on the 7th in a fall from the mountains of the Upper Valais, and died next day in the village of Oberwald. The deceased gentleman was the author of several remarkable works relative to surveys and explorations in the Swiss Alps.

THE *Times of India*, of August 22, asserts that news has been received from Zanzibar that Dr. Livingstone had again been heard of to the west of Lake Tanganyika, whence he had sent to Ujiji, requesting his supplies to be forwarded. A young American was hurrying on by forced marches to Ujiji, in the hope of carrying relief to the traveller. The intelligence appears, however, to want confirmation.

THE Council of the Institution of Civil Engineers publish a list of forty-three special subjects, on which they invite communications for the approaching session, as well as upon others; such as: "*a*. Authentic details of the progress of any work in Civil Engineering, as far as absolutely executed (Smeaton's Account of the Eddystone Lighthouse may be taken as an example). *b*. Descriptions of engines and machines of various kinds. *c*. Practical essays on subjects connected with Engineering, as, for instance, Metallurgy. *d*. Details and results of experiments or observations connected with Engineering Science and Practice. For approved original communications, the Council will be prepared to award the premiums arising out of special funds devoted for the purpose.

THE *Maidstone Journal* mentions that an educational effort of considerable promise is about to be made in that town. Several gentlemen have arranged to conduct junior classes during the evenings of the winter months, the subject being Physical Geography. Three hundred pupils from the senior classes of schools in Maidstone have already entered. The course will consist of thirty lectures, and the pupils will be educated up to the standard of the Educational Department at South Kensington. The lectures will be free.

PROF. HUXLEY has been lately engaged in inspecting and arranging the valuable reptilian and other remains from the Upper Elgin sandstones now placed in the Dundee Museum He has also been superintending some excavations at Lossiemouth, in order, if possible, to obtain materials for completing the structure of the huge Saurian, *Stagonolapis Robertsoni*, a full account of which is expected to appear before the Royal Society shortly.

A FEW years ago the existence of a new Tapir on the Isthmus of Panama was first made known by American naturalists. This animal departs so widely from the ordinary American Tapir in certain anatomical characters (particularly in the possession of a completely ossified septum between the nostrils, as in the Tichorhine Rhinoceros) that Prof. Gill (its describer) thought it necessary to make it the type of a new genus, calling it *Elasmognathus Bairdi*, after the distinguished assistant secretary of the Smithsonian Institution. The Zoological Society of London have just added to their living collection a fine young male specimen of that animal, which has been placed in the elephant house along with an example of the *Tapirus americanus*.

THE German surveying ship, the *Pomerania*, returned from her cruise in the Baltic on the 24th of August, after making some very interesting discoveries. She crossed the Baltic in different directions several times, and during these journeys soundings were carefully taken, the bottom was dredged, and the surface and deep-water currents observed, and the temperature of the water at the surface and at some depth was also carefully noted. These results will shortly be published in full, but a few details have already appeared. The greatest depth between Gothland and Windau was found to be 720 feet, and not 1,110 feet as formerly supposed. At the depth of from 600 to 720 feet, at the latter end of July, the temperature was only from 0·5° to 2° R. No marine plants were met with in this cold area, and only a few annelids were dredged up. Life was very abundant to a depth of about 300 feet, whilst plants were seldom found at a depth of more than 30 feet. Both animal and vegetable life were found to be most abundant on the coasts of Mecklenburg-Schleswig and Holstein and in the bay of Lübeck.

AS an addition to the list of exploring expeditions tending either directly or indirectly to develop a knowledge of the natural and physical features of the North American continent, *Harper's Weekly* states that a party of civil engineers has lately been organised at Victoria to survey a route for a proposed railroad through British Columbia and the Red River country to Canada. This is stated to be provided with ample means for the purpose of making a minute geographical reconnoissance of the country, and is expected to add much to our knowledge of the general geology of the continent.

GREAT geological changes are reported from the districts adjoining the Caspian Sea and the river Ural. During the last ten years the surface of the water in the river has sunk more than a foot, and many bogs on the North Eastern coast of the Caspian have entirely disappeared. The delta of the Ural has diminished from nineteen to five branches, and whereas it formerly occupied one hundred versts, it now occupies only seven. Many islands have become joined to the mainland, and large sandbanks have been formed at the mouth of the river. The town of Guryer, formerly on the sea coast, is now six versts inland.

WE have now full details of the severe cyclone which visited Antigua, St. Kitts, St. Bartholomew, St. Martins, Tortola, St. Thomas, and Porto Rico, on the 21st of August. The heaviest gusts of wind were felt at St. Thomas between 4.30 and 5 P.M., and about 5 o'clock there was a sudden calm; the centre of the cyclone then passing over the island, and by 7 the violence of the wind had ceased. The damage done in all these islands is excessive; in St. Thomas the losses are returned at forty-two persons killed, seven-nine seriously injured, and 420 houses completely destroyed. At Antigua the cyclone was very severe, eighty persons are reported killed, and several hundred wounded. Scarcely a house or plantation in the island has escaped damage. Every place is "bleak, bare, and desolate." No confirmatory accounts are given of the earthquake shocks said in the first telegram to have accompanied the cyclone; they are probably due only to exaggeration.

MR. THOMAS GRAY, the Marine Secretary of the Board of Trade, has collected a sum of 200*l*. as a prize for the most efficient and most simple green light for the starboard side of ships that shall fulfil the Board of Trade conditions, which require that it shall be of sufficient power to be seen on a dark night, with a clear atmosphere, for a distance of two miles uniformly over an arc of ten points of the compass, from right ahead to two points abaft the beam. Lamps intended to compete for the prize should be sent in by the 31st December next.

THE preparations made by the Governments of the present age to have every phase of a total eclipse studied and recorded, contrast favourably with the superstition that prevailed a few centuries ago. For instance, the *Scientific American* quotes the following from a German paper :—"The Elector of Darmstadt was informed of the approach of a total eclipse in 1699, and published the following edict in consequence :—'His Highness, having been informed that on Wednesday morning next at ten o'clock a very dangerous eclipse will take place, orders that on the day previous, and a few days afterwards, all cattle be kept housed, and to this end ample fodder be provided ; the doors and windows of the stalls to be carefully secured, the drinking wells to be covered up, the cellars and garrets guarded so that the bad atmosphere may not obtain lodgment, and thus produce infection, because such eclipses frequently occasion whooping cough, epilepsy, paralysis, fever, and other diseases, against which every precaution should be observed.' "

A NATAL correspondent writes that the diamond fields on the Vaal River cover so large an extent of ground that to effect a thorough search would occupy 20,000 men 100 years. From this assertion it might be supposed that the diamonds lie very deep ; but the contrary seems to be the case, for we are told that they all lie comparatively near the surface, the diggers seldom going down deeper than seven feet. The copper in Namaqualand is likewise found near the surface, and stone implements are also found in a similar position. This is accounted for by the fact that the country is fast wearing down. These implements and other indications of former habitations appear to be abundant in Basutoland. Upon digging several feet below the surface near any of the occupied villages of the Basuto people, stone implements are found, and at a less depth the remains of fire places, broken pots (clay), and ash and cinder heaps are discovered. These remains are very abundant throughout the whole of Basutoland.

AMERICAN naturalists are anticipating with pleasure the promised visit from Mr. Gwyn Jeffreys. He is expected in the course of the summer ; and though his stay will be a short one, it is hoped that he will be enabled to secure personal conference with the leading American naturalists, and to make such an examination of the sea-coast fauna as he desires. He will probably arrive in time to meet Prof. Agassiz before he starts on the expedition, which contemplates the expenditure of at least a year in an exploration of the physics and natural history of the deep seas of both the Atlantic and Pacific, under the auspices of the United States Coast Survey.

SCIENCE forms an important element in the educational course at the Friends' School, Sidcot. From the report and Transactions of the Boys' Literary Society for the past year, we find that sixty-six monthly reports and thirteen original papers on subjects connected with their several departments, have been read by the curators. Careful and systematic observations by a large section of the members have been made in ornithology, and several rare species have been observed. Considerable attention has also been paid to the collection of plants and insects.

THE Ludlow Natural History Society has little to report in the way of active proceedings during the past year, owing to the illness and subsequent death of the secretary, Colonel Colvin. Many details of work, especially in the completion of arrangements, were however attended to. The balance sheet is satisfactory, and the museum attracts a certain number of visitors ; but the donations acknowledged suggest the idea that a collection of curiosities rather than a Natural History Museum is the object of the society. Mr. Alfred Salwey has been elected secretary.

THE Quekett Microscopical Club has just issued its sixth Annual Report, from which it appears that the club continues to maintain its usefulness ; not only has the number of members considerably increased during the year, and the selection of microscopical slides kept for the use of members and the number of volumes in the library been augmented, but the papers read at the fortnightly meetings show that important additions to microscopical knowledge have been made by members of the club. The fortnightly field excursions during the summer months have been well attended. The number of members now amounts to 550.

WE have received an abstract of the reports of the surveys and of other geographical operations in India for 1869-70. It includes notices of Indian marine surveys, the great trigonometrical survey, and the topographical, geological, and archæological surveys during these years, with a chapter on geographical exploration.

THE Royal Society of Victoria is just recommencing the publication of its Transactions, discontinued since 1868 in consequence of the withdrawal since that year of the customary annual grant of 100*l*. from the Colonial Government. Notwithstanding this official discouragement, the society was never in a more prosperous and active condition ; the premises have been rebuilt, and considerable additions have been made to the library.

AN event of rare occurrence has happened in the southern part of the great rainless desert of Atacama, a heavy fall of rain having taken place in Northern Chile on the 31st May from the coast to the Cordillera, and from Tres Puntas to Chonarcillo, including Copiapo. This was, perhaps, an extension of the rains in Southern Chile.

THERE were several earthquakes in Chili and Peru in June. On the 20th there was a strong shock at Tacua about 7 p.m., but no damage was done.

Dr. HENRY CASSERE, a German, has been sent by the Peruvian Government to make a collection of plants and animals in its Amazon territory, which are to form part of the Great International Exhibition at Lima.

THE great subject of excitement in the South Pacific is the continued discoveries in the new Caracoles district of Bolivia. Silver is now being produced at the rate of 4,000 lbs. per day, or 400,000*l*. a year. Coal has been discovered, and new gems are found. The amethyst is the most abundant, and the opal of the finest quality. Marine fossils have been recognised in the formations.

THE artesian well at Umballa had in July reached a depth of 527 feet.

A MINE of silver lead of good quality has been found in the Marwar State in India.

THE sea has made considerable encroachments at Aleppey in India. We lately recorded the high tide which swept over the Laccadive islands.

THE Agri-Horticultural Society of India have reported that the nettle of the Neilgherries furnishes a valuable fibre, at least equal to Rhea grass, but attended with the same difficulties in working.

IT may be of interest to collectors to known that there is now an ornithologist or bird stuffer at Constantinople, Mr. William Pearse, and a dealer at Smyrne, Mr. A. Lawson.

WE must add to our maps the ports of the growing region of Bolivia on its narrow strip of coast. Besides Cobija there are now as trading ports Mejillones, Tocopilla, and Caleta de la Chimba.

GOLD operations are being undertaken at Penang by English enterprise, with great hopes of success. The object is to work the quartz reefs.

GOLD mining is reviving in Colombia or New Granada, a country once famous for its riches.

THE LATE CAPTAIN BASEVI, R.E.

A LETTER in the *Times* of the 19th inst., from Col. J. D. Walker, R.E., announces the death of Captain James Palladio Basevi, of the Royal (late Bengal) Engineers, Deputy-Superintendent of the Great Trigonometrical Survey of India, an officer of great worth and ability, whose loss will be long felt in the department of the public service to which he belonged. He was the son of the celebrated architect, George Basevi, and was distinguished as a lad for more than ordinary talent, and particularly for his mathematical abilities. First at Rugby, then at Cheltenham College, and afterwards at Addiscombe, he won for himself a high position among his fellow students, and in December, 1851, he left Addiscombe as the first cadet of his term, obtaining the first prize in mathematics, the sword for good conduct, the Pollock medal, and a commission in the Honourable East India Company's Corps of Engineers.

The first few years of his services in India were spent in the Department of Public Works in the Bengal Presidency; but in 1856 he was appointed to the Great Trigonometrical Survey of India, in which he continued to serve up to the time of his death, performing many services of great value.

His bent of mind and habits of study led him, however, to feel a preference for the more purely scientific branches of the operations of the Trigonometrical Survey. Thus, in 1864, he was selected to undertake certain operations which had been proposed by the President and Council of the Royal Society for the determination of the force of gravity at the stations of the great meridional arc of triangles measured by Lambton and Everest, which extends from Cape Comorin to the Himalayan Mountains. The investigations were to be effected by measuring the number of vibrations which would be made in a given time by certain invariable pendulums when swung at the several stations.

Captain Basevi entered on the pendulum observations with his characteristic ardour and devotion. He carried his observations of pendulum and clock coincidences over at least twelve days at each station; for ten hours daily—from 6 A.M. to 4 P.M.—he never left his pendulums for more than a few minutes at a time, taking rounds of observations at intervals of an hour and a half apart; then at night he would devote a couple of hours to star observations for determining time.

His observations of the pendulums on the Indian arc showed that the local variations of gravity which are superposed on the great law of increase from the equator to the poles, though apparently irregular when examined singly, are subject to laws which are highly interesting and curious, and are well worthy of investigation. At the northern extremity of the arc the results indicate a deficiency of density as the stations approach the Himalayan Mountains, while at the southern extremity they indicate an increase of density as the stations approach the ocean; thus both groups of results point to a law of diminution of density under mountains and continents, and an increase under the bed of the ocean.

Thus far, however, observations had not been taken at any very great altitudes, the highest station in the Himalayas being under 7,000 feet; arrangements were therefore made to swing the pendulums on some of the elevated table lands in the interior of the Himalayas, which rise to altitudes of 14,000 feet to 17,000 feet. It was expected that this would be sufficient to complete the work in India, and then the pendulums would be taken back to England to be swung at the base stations of Greenwich and Kew, and *en route* at Aden and at Ismailha on the Suez Canal, places which are in the same latitudes as some of Captain Basevi's stations. Thus gravity at Aden would be directly compared with gravity at certain points of the coast and continental stations of the Indian Peninsula, and similarly the plains of Egypt would be compared with the Himalayan Mountains.

In the spring of the present year Captain Basevi proceeded to Kashmir on his way to the high table lands in the interior.

Early in June he reached Leh, the capital of Ladak. He then proceeded to the Khiangchu table land in Rukshu, about eighty miles to the south of Leh. There, at a spot called Moré, in lat. 33° 16′ and long. 77° 54′, and at an altitude of 15,500ft., he completed a satisfactory series of observations, which show a very gross deficiency of density. After applying the usual reductions to sea level, &c., it was found that the force of gravity at Moré did not exceed the normal amount for the parallel of latitude 6° to the south, as determined by the previous observations with the same pendulums.

Wishing to have one more independent determination at a high altitude, Captain Basevi proceeded to the Changchenmo Valley, which lies due east of Leh, across the newly-proposed trade route between the British province of Lahoul and the States of Eastern Turkestan. Near the eastern extremity of that valley, on the confines of the Chinese territories, he found a suitable position in lat. 34·10 by long. 79·25, at an altitude which is not exactly known, but must probably have exceeded 16,000ft. He hoped to complete his observations in ten days, and then commence the journey back to India. But he did not live to carry out his intentions; already the hand of death was upon him, and, all unconsciously to himself, the over-exertion to which he was subjected in a highly rarefied atmosphere and under great vicissitudes of climate was rapidly undermining a constitution which, though vigorous, had already been sorely tried.

With the devotion of a soldier on the battle-field, he has fallen a martyr to his love of science and his earnest efforts to complete the work he had to do, and in him we have lost a public servant of whom it may be truly said that it would not be easy to find his equal in habitual forgetfulness of self and devotion to duty.

SOCIETIES AND ACADEMIES

PARIS

Academie des Sciences, Sept. 11.—M. Faye in the chair. —M. Dumas read an abstract of a pamphlet published by MM. Lomer and Ellershausen, advocating the establishment at Bellegarde, in the department of Ain, of hydraulic machines worked by the Rhone, and giving a force of 10,000 horse-power. The site is called "Le perte du Rhone" at Bellegarde, and this immense hydraulic pressure is to be obtained by boring a tunnel, through which only one-third of the water of the Rhone will go. The height of the fall will be sixty feet, and the result is to be obtained very easily, as the tunnel is only to have a length of 550 yards. The engineers hope to create at Bellegarde a city as important as Lowell in the United States. It is intended to induce Alsatian manufacturers to move from Mulhaus, and to settle in that locality.—M. Decaisne sent some observations relating to animals fed with bread infested with the *oidium aurantiacum*, and it is considered as demonstrated that, at least under special circumstances, such food must be considered as being really poisonous. —M. Berthelot sent a very long paper on the union of alcohol with bases, which was inserted *in extenso* in the *Comptes Rendus*. —M. Lecoq de Boisbaudron sent also a paper which was published by him some time ago, on the constitution of luminous spectra. —M. Favre sent a paper to elucidate certain points of a special theory worked out to explain how a certain weight of copper rotating between the poles of an electro-magnet is heated by the influence at a distance. The fact was discovered by Foucault.

SAN FRANCISCO

California Academy of Sciences, August 22.—Mr. Dall called the attention of the members to some shells of oysters that had been transplanted from the Eastern States, and which during the last twelve months had been growing in the waters of the bay. The recent growth of these oysters had been modified in a manner so that they corresponded very closely to that of our native oyster. In the eastern oyster the shell is white and smooth, whilst our bay oyster has the shell much corrugated, of a brown colour, and frequently with purple stripes between the ridges. Now the recent growths of the shell of these transplanted eastern oysters exhibit the same corrugations as our native, the colour is decidedly more brown than in the east, and purplish stripes are frequently found between the corrugations. —Dr. Blake gave a description of some prismatic dolerite found in the neighbourhood of Black Rock, Nevada. The prisms were six-sided, measuring from 0·1 in. to 0·3 in. across, and some were from 3 in. to 4 in. long, but they all had evidently been broken. The separation of the crystals was caused by weathering, as in some specimens they were still aggregated. A thin section under the microscope showed that the rock was composed of augite, nephaline, and titanite, imbedded in a green vitreous matrix. Dr. Blake also read a paper on the diatoms found in the Puebla hot spring, Humboldt county, Nevada. The temperature of the water where they were collected was 163° F. They were contained in the decomposing layers of an abundant growth of red algæ, which formed a membranous covering at the bottom of the channel, through which the waters of the spring were discharged. This growth consisted of oscillariæ and a minute hair-like alga, which presented nothing but a mere outline even when magnified 700 diameters. This alga seems identical with the *Hygrocrosis Bischofi* found by Cohn in carnallite. By the interlacement of its fibres it formed a tough membranous layer covering the bottom of the channel, but this layer was coloured red, apparently by the oscillariæ. In the upper layer of these algæ but few diatoms were found, but those layers which had been covered in by new growths, and which were in a semi-gelatinous state, afforded a nidus in which the diatoms seemed to flourish with the greatest luxuriance both as regards species and individuals. In one slide, without any previous preparation of the deposit, as many as forty-six species were observed. But the most interesting point in connection with them is their almost perfect identity with the diatoms found in the infusorial strata in Utah, and which have been so fully described by Ehrenberg in his recent memoir on the Bacillariæ of California. Amongst the more marked species which were peculiar to the Utah strata, Cocconema unciale-Hyalodiscus Whitneyi, Stephanolithis hispida, and Cosmiolithis Henryi were readily recognised; in fact, had it not been for the presence of a small quantity of these hair-like algæ in the recent specimen, it might have been regarded as having been taken from the Utah beds. The resemblance of form between these hot spring and Utah diatoms, and the fact of their growing so luxuriantly in water so hot as to render it unfit to support any other form of living being, makes it more than probable that the Utah infusorial layers were formed in an inland fresh-water sea, the temperature of which was probably about the same as that of the Puebla hot spring. The great difficulties in explaining the formation of these extensive infusorial deposits have been the time required for their formation, and also the entire absence of all other fossil remains in strata that were evidently quietly deposited in fresh water. Both these difficulties are removed by admitting that the inland sea in which they were formed was of a temperature which is seen to be most conducive to their rapid growth, and which, at the same time, was incompatible with the existence of other forms of living beings. It is probable that the temperature of the air was not much below that of the inland sea, so that no land plants or animals could exist at the time when the Utah beds were being deposited. The admission of the existence of such an extreme climate even in the temperate zone at so recent a period as the post-pliocene (the position these beds are supposed to occupy) would certainly lead to important modifications in our views as regards the condition of the surface of the earth at that period. The author thinks it probable that these Utah infusorial beds are miocene, as at the close of that period we know that the temperature of the Arctic region was some fifty or sixty degrees warmer than at present. He proposes in a future communication to enter more fully into this question, and also to consider the bearing of the discovery of the production of these low forms of living beings in such apparently abnormal conditions on the origin of living matter. — Prof. Whitney gave an account of the investigations carried on during the progress of the Geological Survey of California, having for their object the determination of the value of the barometer as a hypsometrical instrument, the expectation being, that after a sufficient stock of observations shall have been accumulated and reduced, it will be possible to designate the hours of the day for each month when the result will approach nearest to the truth; and in general to give practical rules in regard to the times of observing and the methods of reduction, the following of which will secure a close approximation to accuracy than can now be attained. An elaborate series of observations with this end in view was begun on this coast some ten years after by Colonel R. S. Williamson, of the U. S. Engineers; but the work was suspended by the Engineer Buseau just before being completed. Colonel Williamson's results, however, were published in the form of a superb quarto volume, as an "Engineer Paper," and this contains a large amount of valuable material, so that the work of the Geological Survey is only to be looked upon as supplementary to that so ably commenced by him. The stations at which observations are being carried on at present, under the direct on of the Geological Survey, are along the line of the Central Pacific Railroad, and their elevations are presumed to be accurately known from the levellings of the railway surveyors. The points selected are San Francisco, Sacramento, Colfax, and Summit, approximately 0, 30, 2,400, and 7,000 feet above the sea-level. The observations have already been continued at these points nearly a year, and are made at the Smithsonian hours (7 A.M., 2 P.M., and 9 P.M.). The greatest care has been taken that the instruments should be kept in perfect order, well placed for accurate results, and carefully and punctually observed. The observations of the first ten months have already been partially worked over by Prof. Pittee, of the Geological Survey, and the results attained indicate very clearly that valuable assistance will be derived from the completed series in the reduction of the copious barometric determinations of altitude made during the progress of the survey.

BOOKS RECEIVED

ENGLISH.—Hardy Flowers: W. Robinson (Warne and Co.).

AMERICAN.—Mammals and Winter Birds of East Florida: J. A. Allen.

FOREIGN.—Verhandlungen des naturhistorischen Vereines der preussischen Rheinlande; Parts 1 and 2.—Sitzungsberichte der Niederrheinischen Gesellschaft zu Bonn, 1871.—Schriften der Naturforschenden Gesellschaft in Danzig.

PAMPHLETS RECEIVED

ENGLISH.—On the Spirit Circle: Emma Hardinge.—Transactions of the Literary Society of Sidcot School for 1870-71.—The Climate of Brighton: S Barker.—The Dependence of Life on Decomposition: H Freke.—A Complete Course of Problems in Plane Geometry: J. W. Pallisser.—Sixth Report of the Quekett Microscopical Club.—On the Relative Powers of Various Substances in Preventing the Generation of Animalculæ: J. Dougall, M.D.—Testimonials in favour of J. W. Davidson, candidate for the Chair of Anatomy in the Edinburgh Veterinary College.—The Traveller; Vol. I., No. 5.—Water not Convex, the Earth not a Globe: W. Carpenter.—On the Economical Production of Peat and Charcoal.—The Contagious Diseases Act and the Royal Commission.—Some Simple Sanitary Precautions against Cholera and Diarrhœa: M. A. B.—The proposed India and England Railway: W. Low and G. Thomas.—Contributions to the Knowledge of the Meteorology of Cape Horn and the West Coast of South America.—Transactions of the Geological Society of Glasgow; No 3, Supplement.

AMERICAN AND COLONIAL.—Fourth Annual Report of the Trustees of the Peabody Museum.—Transactions of the Entomological Society of New South Wales; Vol II., Part 2.—Notes on the Birds of New Zealand: T. H. Potts.—Arrangement of the Families of Molluscs: T. Gill, M.D.—On the Early Stages of *Terebratulina septentrionalis*: E. S. Morse.—What are they doing at Vassar? Rev. H. H. Macfarland.

FOREIGN.—Le Chiffre Unique des Nombres.—Sulle Distribuzione delle protuberanze intorno al disco solaro: P. A. Secchi.

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ERRATUM.—Page 383, second column, lines 4, 11, for "Geneva" read "Genoa."

NOTICE

We beg leave to state that we decline to return rejected communications, and to this rule we can make no exception.