THURSDAY, SEPTEMBER 28, 1871

EXPERIMENTAL SCIENCE IN SCHOOLS

The Elements of Physical Science. By Gustavus Hinrichs, A.M., Professor of Physical Science in the State University of Iowa, &c. In 3 vols. Vol. I. Physics. (Griggs, Watson, and Day, Davenport, Iowa, U.S.)

The School Laboratory of Physical Science. Edited by Gustavus Hinrichs. Nos. 1 and 2.

"BY resolution of the Board of Regents in 1870, the Iowa State University has finally cut loose from the old college course. Only by this resolution, *placing the elements of Physical Science at the very beginning of the course*, can instruction in science become thorough. For the first time the students in physical science have been offered facilities not too inferior to those they have for ten years enjoyed in other branches of learning." And with what result? "A marvel of studious industry there" (in the laboratory). "Young men and young women, boys and girls, measuring, weighing, testing, demonstrating, and recording fact upon fact in physics, that, at least in our school days, were pored over in a maze of bewilderment, in dryest of text-books, to be bolted in sections without question." We trust that these important reforms in science teaching will prove contagious, and spread rapidly from the plateau of Iowa City to a region of even greater extent than the American continent. Let us examine how Prof. Hinrichs is doing his part to attain this desirable result.

Bearing in mind the important fact that science teaching in schools must be of a practical nature from beginning to end, the American Professor has sketched out in his "School Laboratory" a plan which in the main will recommend itself to every competent teacher both in his own country and in ours. He proposes that the course shall be divided into three parts :—Rudiments, Elements, and General Principles. The Rudiments, which ought to be studied in the first year or so of a boy's school life, embrace only prominent general facts and determinations, easily observed and measured with a sufficient (but limited) degree of accuracy ; together with the collective study of these facts, so as to bring to light several of the so-called laws. The Elements comprise the same subjects, treated however, more fully, and they should be completed "in the first year of the high school course." The General Principles embrace mathematical deductions of a concise and simple nature, together with some of the most important hypotheses of Physical Science ; this portion should be completed in the last year of the high school course. Prof. Hinrichs is careful to point out that technical instruction in schools will not result in the advancement of science ; but that a thorough general training in the phenomena of Nature, together with that already given in languages and mathematics, will lead to hitherto unimagined progress.

Such is Prof. Hinrichs' idea of a sound scientific training, and a very admirable one it is. To carry it out we must strive after good teachers, capacious laboratories, and trustworthy text-books. For our own part, we think that good teachers would not be found so scarce as is imagined, if there were only a genuine demand for them ; from a variety of causes, however, such as parental ignorance, false economy on the part of schools, and the ridiculous demands of public examiners, science has been kept, up to the present time, at the lowest possible ebb, except in the wealthiest of our public schools. It is deplorable to think how few school laboratories there are in England which could in any way vie with that in the Iowa State University, where "more than two hundred students have experimented within six months ;" and we fear that this state of things will continue for the most part unaltered until the public examiners require a *practical* knowledge of the sciences taught in schools.

We are perhaps as deficient in good text-books as we are in laboratories ; and the reason for this is not far to seek. If a candidate is asked to explain a phenomenon or a class of phenomena, but is never required to exhibit it to the examiner, it is natural that he should content himself with learning the explanation without performing the experiment. Hence we find that the great majority of our text-books are merely explanatory, and not at all experimental ; the phenomena are fully described and most ably explained, but the work which should be done in the laboratory to bring about these phenomena is forgotten by the teacher and the taught, because—*it is not required at public examinations.* It was therefore a bold undertaking for Prof. Hinrichs to bring out his "Elements of Physics," which is an excellent and almost unique specimen of a practical treatise ; and we trust that it will meet with a reception worthy of it.

In the first volume of this work, the student is taken, in about 150 pages, through a course of simple and easy experiments relating to Magnitude, Weight, Machines, Properties of Matter, Light, Electricity, and Magnetism. Each operation is so clearly described that the book might almost be employed by a solitary student, and many of the experiments, we are convinced, not only could but ought to be performed by children at the very commencement of their school career.

There is great difference of opinion as to whether qualitative and quantitative observations of natural phenomena should be performed simultaneously or consecutively—we are disposed to hold the latter view rather tenaciously, believing that science should be one of the first subjects taught in all schools. However, no one need be dismayed by the simple measurements of length, area, weight, and so on, which form the main portion of Professor Hinrichs' first chapter. The metrical system is taught by him in the only practicable manner, by means of actual measurements performed by the pupils themselves, without any reference, beyond a passing contemptuous notice, to the English system. The student is also familiarised with various forms of surfaces and solids, learns the management and the use of very simple apparatus, such as could well be provided in any village school, constructs his own measures of weight and length, makes numerous determinations, and enters his results in a journal. The exercises in mensuration and co-ordinates are especially useful, both from a scientific and a mathematical point of view ; and the Journal of Experiments—blank pages at the end of the volume to be filled up by the pupil—is perhaps the most suggestive portion of this original work. In short, the experimental method is adopted in every chapter; and it is thus that the inquirer after truth is taught, step by step, to appeal to the fountain source for most, if not all, information concerning "the wonder and mystery of Nature."

There is, however, a very marked disproportion in the amount of space allotted to each subject. Machines occupy only sixteen pages—probably the feeblest chapter in the book; while Crystallography extends over as many as thirteen pages. We think also that too much attention (relatively, at least) has been paid to Electricity and Magnetism. Pure and simple observation, even of natural phenomena, cannot properly be said to educate the mind, unless the reasoning faculties are called into play; and such subjects as Electricity, Botany, and Crystallography, if made an essential portion of school training, would doubtless tend to bring the whole question of science-teaching into disrepute. The only experiments that should be performed in the laboratory are such as will bring to light a scientific fact; and it should be remembered that a fact is scientific only in so far as it is interconnected with other facts. The more intimate this interconnection is, the better suited is the fact for elementary education; because it gives rise to a greater amount of rational explanation, and tends, by reaction, to imprint upon the mind knowledge already acquired. Professor Hinrichs does not appear to us to attach sufficient importance to these views; his work has therefore a disjointed aspect, and is wanting in large general ideas which should be cautiously introduced at proper intervals for the purpose of increasing the scope of the pupil's understanding. We agree with him that the quantitative study of such subjects as the Law of Gravitation should be postponed to the last year of the school course; but its qualitative study might be carried on with great advantage at a much earlier period; for previous familiarity with such theoretical views as are capable of some sort of experimental proof will make a student anxious to examine the subject quantitatively at the earliest opportunity. For these reasons we regret to find certain points omitted in the present volume, such as the Laws of Motion, which are so admirably adapted, not only for experimental verification, but as a means of explaining the principles of scientific induction. Still, if Prof. Hinrichs has not discovered every gem, he has nevertheless succeeded in pointing out the right path of discovery, along which he has acted on the whole as a faithful and thoroughly painstaking guide.

The idea of the "School Laboratory" is also a very admirable one. It is, in fact, a monthly magazine, the aim of which is to inculcate the system of experimental work upon which Prof. Hinrichs so strongly insists; to give examples of methods and results; and to aid both teacher and pupil.

We trust that the efforts of this able reformer of science-teaching will be amply seconded; and we believe that these Elements will be found of great service to every conscientious teacher, who will be able to glean from them many valuable suggestions both as to method and treatment; and we recommend them especially, because a widely-spread knowledge of a work of this kind will tend very much towards the introduction of experimental science into the curriculum of our schools.

OUR BOOK SHELF

Phrenology, and how to use it in Analysing Character. By Nicholas Morgan. (London: Longmans, Green, and Co. 1871.)

THE appearance of a book of this kind from time to time shows what a deep hold phrenology took upon the popular mind. Had it not been so, we should have neither writers nor readers of works upon "The Science of Phrenology," now that almost the whole foundations of the system have been shown to be either untrue or based upon misconceptions. The present work is illustrated by numerous portraits and other engravings, and several of the former are remarkably truthful representations of living or recently-living celebrities; though we doubt whether the accompanying analyses of character will prove as agreeable to the originals as they are destined to be edifying to the public.

The Dependence of Life on Decomposition. By Henry Freke, M.D., T.C.D., &c., Professor of the Practice of Physic and Lecturer on Chemical Medicine in Steven's Hospital Medical College. (London: Trübner and Co.)

THIS is a pamphlet of a controversial character, which would not prove interesting to the general reader. Dr. Freke's views were originally published in 1848 in a work "On Organisation." They are peculiar in many respects, but contain the germs of some important biological truths. The following passage (p. 28) may serve as an example:—"Why, with an adequate supply of food, are we not able to work our brains, muscles, &c., for an *indefinite* period, like a steam-engine with an adequate supply of steam? Because the tissues are disintegrated, and require nutritive repair. If the animal tissues did *not* undergo disintegration during the active discharge of their functions, why should not the animal, like the vegetable, continue to increase in dimensions during the entire period of its organic existence? It is because the organic tissues developed by the vegetable do *not* undergo disintegration when their construction has been completed, that the vegetable continues to grow and increase in dimensions during its entire life. Such is not the case with the animal, and that for this reason, namely, when the construction of the animal tissues, brain, muscle, &c., is completed, those tissues undergo disorganisation while discharging their functions."

The Estuary of the Forth and adjoining Districts viewed Geologically. By David Milne Home, of Wedderburn. (Edinburgh: Edmonston and Douglas.)

MR. MILNE HOME'S name has long been known in connection with Scottish geology. His memoir on the Coalfields of the Lothians was for many years the only trustworthy geological account of those areas. In addition to this he has from time to time communicated to various scientific journals a number of papers chiefly on subjects relating to glacial geology. In this present volume he returns to these subjects, and gives us a description of the superficial formations of the basin of the Forth, together with what he considers to be the most feasible explanation of the somewhat intricate details he brings before his readers. He treats first of the form and physical features of the Estuary and the districts adjoining; secondly, of the formation or origin of the Estuary; and, thirdly, of the superficial deposits met with in the area described. He conceives that the faults which intersect the strata along both sides of the Firth, and which not only have the same general bearing as the Estuary, but are also for the most part downthrows to south, in Fifeshire, Clackmannan, &c., and, in the Lothians, downthrows to north, have formed the deep trough or valley of the Forth—the depression caused by this series of step-faults having reached at least 2,000 feet. "Along the lines of these slips great precipices, or cliffs, were formed, several hundred feet in height, which, under the action of the sea or the atmosphere, crumbled down." The materials thus supplied went to form the superficial deposits, it being supposed that almost the whole of Scotland was under the sea at the time these changes took place. We feel sure that Mr. Milne Home will get few geologists to agree with him in these conclusions. In the first place, it may very well be doubted whether the faults which cut the strata ever actually showed at the surface in the manner supposed. It is much more probable that the dislocations took place so gradually that any inequalities arising therefrom were planed away by denudation as fast as they appeared. But even were this not the case, it is quite certain that the faults referred to by Mr. Milne Home must date back to a vastly more remote antiquity than the later Tertiary periods. The Scottish Coal-fields, indeed, would appear to be traversed by some faults which, according to the Geological Survey's map and description of the South Ayrshire Coal-fields, do not influence the overlying Permian. It is also indisputable that the igneous dykes, which Professor Geikie has shown to be of Miocene age, are all posterior in date to the faults which shift the Coal-measures. Mr. Milne Home does not take into consideration the prodigious amount of denudation that the palæozoic strata of the valley of the Forth must have undergone in the long ages that intervened between the close of the Carboniferous period and the advent of the glacial epoch. There cannot be any reasonable doubt that the valley of the Estuary of the Forth existed as a valley long before the dawn of the age of ice. But Mr. Milne Home's memoir is taken up chiefly with the history of the drift deposits, which he describes in considerable detail. Especially valuable are the numerous sections given, and the long lists of localities where glacial-striæ, erratic blocks, kaims, and the other phenomena of the drift, may be studied. The author inclines to the iceberg theory of the formation of the boulder-clay, and thinks it may have originated at a time when "the ocean over and around Scotland was full of icebergs and shore-ice, which spread fragments of rocks over the sea-bottom, and often stranded on the sea-bottom, ploughing through beds of mud, sand, and gravel, and blocks of stone, and mixing them together in such a way as to form the boulder-clay." Mr. Milne Home points to the presence of beds of sand included in the boulder-clay as one of several objections to the land-ice origin of that peculiar deposit. He thinks that if the iceberg theory be adopted, the explanation would be simply this, "that icebergs came at different periods, new sea-bottoms being formed in the intervals." But, on the other hand, if the glacier theory be accepted, then it would have to be admitted that the land must have sunk under the sea for every bed of sand we find in the boulder-clay. The author, however, does not seem to be aware that fresh-water beds are found interstratified with the boulder-clay, so that the difficulty in either case is equal. We have not space to notice several other interesting points treated of in this memoir, which contains so many important data, that we can recommend it confidently to our geological readers. We may dispute some of the author's conclusions, but it matters not what interpretation may eventually be put upon the facts, many of the facts are here, and Mr. Milne Home has done good service in bringing them together.

J. G.

LETTERS TO THE EDITOR

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

Phenomena of Contact

In Nature for August 24, Mr. Stone controverts two propositions incidentally put forward in a review of Mr. Proctor's book, "The Sun." They are:—

"1. That the irregular phenomena of internal contact of a planet with the sun, variously described as 'distortions,' 'black drops,' 'ligaments,' &c., are not always present, but are only seen 'sometimes.'

"2. That when seen they are due to insufficient optical power or bad definition."

In writing that review, I tried to avoid the assertion of any proposition I could not fully sustain, and therefore very willingly give the evidence on which these propositions rest. At the outset, however, I beg leave to call especial attention to the fact that I did not assert the second in an absolute manner, but only said that it was "indicated" by observations and experiments.

The first proposition is sustained by the fact that at the last transit of Mercury, the majority of those observers who have described the phenomena saw neither ligament nor distortion, but only the geometrical phenomena of contact, the planet preserving its rotundity to the last.

The following is a statistical summary of the evidence on both sides:—Among the numerous English observations published in the monthly notices, fourteen describe the phenomena. Of these three saw the phenomena go on regularly, while eleven saw ligament, black drop, or distortion either before or after the contact. Among these eleven there is little agreement as to the exact nature of the distortion. Owing to the low altitude of the sun in England, I take it that the atmosphere was much less favourable than on the Continent.

At Marseilles Le Verrier saw the black drop. He used a seven-inch glass, of which both the centre and circumference were covered by a screen, which is sufficient to account for the phenomenon by the diffraction thus produced. Mr. Stephen, who observed at the same place with a very large reflector, "déclare n'avoir rien vu de pareil." *

Of the five observers at the Paris Observatory, Le Verrier says†:—"Les observateurs ont remarqué qu'il ne s'est rien présenté de particulier, ni au moment du contact intérieur, ni après ce contact. Mercure a touché le bord du Soleil en amincessant progressivement le filet de lumière, mais sans produire le phénomène de la goutte." Le Verrier was, therefore, so far as we know, the only observer in France who saw the black drop.

At Madrid Ventosa may have seen several black drops "tout-à-coup." His description, however, is rather obscure.‡

At Lund the egress was observed by Duner under very favourable circumstances with a nine-inch glass. He says§:—"Die Bilder waren sehr ruhig, und die innere Berührung geschah in der Weise, dass der Lichtfaden Zwischen den Rändern des Mercurs und der Sonne erst dann brach als seine Breite verschwindend klein geworden war. Es zeigte keine Spur einer Verdrehung der Bilder oder des von anderen Beobachtern erwähnten schwarzen Tropfens."

At Pulkowa fourteen observers observed the egress. I learn that not one saw anything but the geometrical phenomena of contact.

To avoid a tedious collation of accounts which nearly all say the same thing, I remark that only two observers on the Continent saw any abnormal phenomena, namely, Kaiser at Leiden, and Oppolzer at Vienna. The first saw an elongation of the planet, which he thought might be due to maladjustment of his instrument.|| The second saw the sun's limb pushed out by that of Mercury, so that apparent contact took place before the breaking of the thread of light.**

Summing up all the accounts, I find the result to be:—

Total number of observers who describe phenomena .	39
Number who saw the planet remain perfectly round, and the phenomena of contact occur with entire regularity, and without distortion, ligament, or drop	24
Number who saw ligament, distortion, one or more drops, or other abnormal phenomena	15

The twenty or thirty observers who do not describe the phenomena probably saw nothing abnormal, but they are not counted in the above list.

The first proposition is, I conceive, fully established by the statistical facts cited.

Passing now to the second, it may be remarked that when different observers give different descriptions of the same

* Comptes Rendus, 1868, ii., p. 921-924.
† Ibid. p. 948.
‡ Astronomische Nachrichten, vol. lxxii., p. 356.
§ Ibid, p. 378.
|| Ibid, vol. lxxiii., p. 214.
** Ibid, vol. lxxii., p. 347.

phenomena, there must be some corresponding difference in the circumstances of observation, and that when among five observers three see the phenomena exactly as we know they are, while two see them as we know they are not, and even then do not agree between themselves, there is a strong presumption that the latter do not see them rightly. I am aware of but a single attempt to determine experimentally the causes why one-third of the observers of the late transit, and many observers of former transits, saw the planet distorted, namely, that of Wolf and André, to which Mr. Stone alludes. They found, in observations of artificial transits under various circumstances, that when they used a telescope of at least twenty centimetres aperture, with a good object glass, well adjusted to focus, they saw only the geometrical phenomena of contact, while, if the object glass was small, or not well corrected for aberration, or not well adjusted to focus, they saw the phenomena of distortion.*

In the absence of farther investigation, which is much to be desired, these results seem to me, at least, to "indicate" that the phenomena in question are due to insufficient optical power, or bad definition either in the object glass or the atmosphere. At the same time I by no means insist on this proposition as established, and it is a great defect in the experiments in question that they do not extend to the effects of using shades of different degrees of darkness in observing the sun; but of this anon.

In his letter Mr. Stone quotes the observations of Chappe, Wales, Dymond, &c., in 1769; but I cannot admit that they bear strongly on either of the points in question, till we have some better evidence than now exists that their object glasses were such as Clarke or Foucault would call good.

Again, the argument from irradiation, if it proves anything, proves too much. I do not see why, upon the theory of Mr. Stone, the distortion should not always be seen. To be satisfactory, any theory of the matter must explain why it is that A, B, C, &c., see the phenomena, while X, Y, Z, &c., do not, and that of Wolf and André is the only one which does this.

Mr. Stone objects to the experiments of the Paris astronomers, that their disc was not sufficiently illuminated to exhibit any optical enlargement. I do not know his authority for this assumption, but, whether well founded or not, it seems to me that if the sun were viewed through a dark glass, it would present the same optical phenomena of irradiation with a disc so illuminated as to appear of the same brilliancy with the darkened sun. Thus, in the absence of evidence to the contrary, the Paris experiments may be taken as showing how the phenomena would present themselves in the case of the sun viewed through a shade of a certain (unknown) degree of darkness.

Before we can make any application of the theory of irradiation to the phenomena of contact, we require to know whether the irradiation of an extremely minute thread of light, darkened so as to be barely visible, is the same with that of a large disc. I am decidedly of opinion that it is not, and, if not, the fact that the sun's disc is optically enlarged by the telescope or the eye of the observer, cannot be directly applied to the phenomena of a transit.

To sum up my views;—neither Mr. Stowe nor any one else will claim that the ligament he saw before the time of internal contact was a celestial reality—he considers it a result of irradiation, but whether of telescopic or purely ocular irradiation I do not understand. If the former, this is simply a species of bad definition, and there is little difference between us. I also admit, on my part, that if the telescope and the eye are such that from any cause whatever an exceedingly thin thread of light presents itself to the sense as a band several times thicker than it really is, then, as the real thread becomes invisible, the seeming band will appear to be broken through by what some may consider a ligament and others a black drop, and the really sharp cusps will seem to be rounded off at their points. If I rightly understand Mr. Stone, he holds that these results of the thickening of the thread of light by what he considers irradiation are unavoidable. But this view is conclusively negatived by the fact that they actually were avoided by a large majority of the observers of the late transit. Admitting, then, that these spurious phenomena are not unavoidable, it matters little whether we call their cause irradiation or bad definition, though it is important that we should know its exact nature. The only attempt I know of to determine this is that of Wolf and André, and their results seem to me so nearly in accordance with what we should expect, as to be quite worthy of acceptance, at least in the total absence of rebutting evidence.

SIMON NEWCOMB

* Comptes Rendus, 1868, i. p. 921.

Solar Parallax

I HAVE waited somewhat anxiously for Prof. Newcomb's statement of the errors in a chapter on the Sun's distance ("The Sun," Chapter I.). His review was certainly so worded as to imply very gross inaccuracy, and his explanatory letter, in which he remarked that more than a column of NATURE would be needed for the mere record of my errors, did not improve matters. This morning I have received his notes. The errors enumerated amount but to seven in all; I will leave your readers to judge of their importance.

1. At p. 50, I assign to Hansen's letter of 1854 the announcement of the value 8″·9159 for the solar parallax; whereas this value was not announced by Hansen until 1863. *Tanquam referat.* Hansen's priority remains unaffected by the change.

2. At p. 53, I mention that Prof. Newcomb deduced a value of 8″·84 (probably a misprint for 8″·81) for the solar parallax by a certain method. His real result was 8″·809. Again my comment is *tanquam referat.*

3. At p. 53, Foucault's "parallax is given as 8″·942, whereas the result actually deduced was 8″·86." The matter again is utterly insignificant; but it chances that I have not given Foucault's estimate of the parallax as 8″·942. I remark only that if Foucault's estimate of the velocity of light is correct, the parallax would be 8″·942. I deduced this result by a calculation made on my thumb-nail as I wrote. It is correct, however, and Foucault's was not.

4. At p. 59, I say that Mr. Stone deduced the solar parallax from observations of Mars made at Greenwich alone, and then by combining these observations with others deduced the solar parallax at 8″·943. Now, Prof. Newcomb says that he "finds no discussion of the observations at Greenwich alone, *in the paper here referred to.*" But I refer to no paper whatever. A rough calculation of the parallax was certainly made from the Greenwich observations alone, though, as Mr. Dunkin remarks at p. 507 of his edition of "Lardner's Astronomy," "the observations by this method (single-station observations) were comparatively unsuccessful," "owing to unfavourable weather at Greenwich." Apart from the facts, which fully justify my statement—what could the correction be worth in any case? Only the final result was insisted upon.

In a note on this matter, Prof. Newcomb makes "in passing" the really important observation that the method of determining the sun's distance by observations on Mars from a single station was applied by the Bonds as far back as 1849. Mr. Carrington had already told me that he believed the Bonds had anticipated the Astronomer Royal. I wrote to Prof. Young asking for further information, and was waiting for his reply. I am obliged to Prof. Newcomb for aiding me in this matter. The priority of the Bonds in this matter should certainly be more widely known than it is.

5. At p. 61. This is a very curious correction. I speak of Prof. Newcomb as having successfully treated the problem which was *afterwards* discussed by Mr. Stone; and he remarks that he knows nothing of the matter, and has read my statement with great bewilderment. I am not responsible for it. There is a letter in the *Astronomical Register* for December 1868, signed only "P. S.," but with unmistakable internal evidence of coming from the Astronomer Royal for Scotland, in which the following passage occurs:—"I must not say a word about the pyramid sun-distance here, or my letter will never be allowed to see the light; something, however, on the score of modern justice to our contemporaries I must beg leave to put in. Admirable is the praise given to Mr. Stone, and worthy, in so far, the credit abundantly bestowed on him at every step of the undertaking; but why is there not one word about Prof. Simon Newcomb, of America, having already gone over that same problem similarly, and published the results a year sooner?" Of course, as Prof. Newcomb now writes that "he has no recollection of ever having made any independent investigation of the observations of the transit of Venus," Prof. Piazzi Smyth was mistaken, and "the abundant discussions of Prof. Newcomb's paper in various northern scientific societies last winter" (so speaks Smyth) were founded on some misconception of its purport. But Prof. Smyth's statements were permitted to remain uncorrected;—*hinc illæ lacrymæ.*

6. At pp. 61, 62. "The distortion of Venus at the time of internal contact is described as an ever-present phenomenon, and the apparent formation of the ligament as contemporaneous with true internal contact." If what I say in pp. 61, 62 admits of being so misinterpreted (which I question), the same cannot be said of

my remarks in p. 63. My belief is now, as it has been for years (long before Mr. Stone's paper was published), that under favourable conditions an exceedingly fine ligament must be visible at the moment of real internal contact, the planet's outline being otherwise undistorted. But in most instances a coarser ligament is formed *not* contemporaneously with the moment of real contact. I have shown that the true moment of contact can be *inferred* from the formation of a coarser ligament as exactly as when a fine ligament is observed. This I still maintain, and I further believe that Mr. Stone's opinion as to the cause of the phenomenon, an opinion independently enunciated by myself in November 1868 (see *Scientific Opinion*) is correct, and that the experimental tests which have been supposed to disprove it, have in reality no sufficient bearing on the question at issue.

7. At p. 63. It is unfortunate if my account of Stone's proceedings suggests that I maintain he was the first to consider whether real or apparent contacts had been observed; for I have but lately been maintaining the contrary view in a correspondence with an ex-president of the Royal Astronomical Society. I have invariably opposed the opinion here ascribed to me. Mr. Stone himself has never claimed what I am said to have claimed for him, He has made a definite claim, and that claim I have repeated and still hold to be just.

Prof. Newcomb concludes with some general statements. He considers I am mistaken in supposing that astronomers generally regard observations on Venus in transit as the most trustworthy method of obtaining the solar parallax; mistaken again in supposing that Mr. Stone has removed any "difficulties that had perplexed astronomers;" and so on. Such statements are so vague that I shall scarcely be expected to discuss them. Until proof, or at least some evidence to the contrary, is supplied, I can only say that now, as when I wrote "The Sun," my opinions on these points seem to me to be just. I am certainly not alone in holding them. RICHARD A. PROCTOR

Brighton, September 23

Elementary Geometry

THE question raised on this subject naturally consists of two parts. The first relates to the unsuitableness of Euclid as a text-book, and the need of a work which shall so commend itself to examiners and teachers, so to supplant it. The second question is —given the authoritative text-book, how is the geometry of which it treats to be taught to young students? The arguments on the first of these questions have been so ably and conclusively stated lately by several mathematicians, especially by Mr. Wilson, Dr. Joshua Jones, and Dr. Hirst, that there is no need to revive the discussion; but I entirely agree with your correspondent in his conclusion that the book which is to supplant Euclid is at present a desideratum, and that it will probably be the work of more heads than one. Several books have been written during the last four years, and have formed the basis of the discussions which have since taken place on the requirements of the new programme. By their means, the questions at issue between the opponents and supporters of Euclid have become more clearly defined, and a greater unanimity of action has resulted amongst those who are labouring to supply this desideratum of modern education. But I am sure that most of these authors will admit that the issue of works intended for permanent text-books was premature.

When the first question is settled, the second remains. Geometry is not essentially difficult, nor is it generally distasteful to young students. It becomes so, however, when they are required to commit the propositions to memory before they understand them. The educational purpose which geometry serves is not the discipline and exercise of the memory. A choice and pregnant passage from a good author may be learnt and retained in the memory without much difficulty, although its meaning may be very imperfectly understood, and it will richly repay the labour of its acquisition. It will be recalled again and again, and receive new light, and afford new pleasure with every fresh association. Not so with geometry; it is useless if not understood. A child should be made to comprehend even the definitions before he commits them to memory. Let us suppose, for instance, that the definition of a circle is to be learnt, the preliminary explanation should take some such form as the following.

The teacher at the black-board, with chalk and compasses, and the pupils at their desks, with paper and compasses—the teacher draws a circle and names the figure—he tells each boy also to make a circle, and then proceeds to question. What name is given to such a surface as that on your drawing paper? What kind of a figure shall we call one which can be drawn on a plane surface? Compare a triangle and a circle, and say how many lines form the boundary of the triangle? How many lines contain the circle? Explain exactly what you do with the points of the compasses when you use them to make a circle? Why must the joint of the compasses be tight? Fix a drawing-pin in your drawing-board, and with a piece of thread construct a circle. What purpose does the thread serve in the construction? The defining properties of a circle are, therefore, these—(1) it is a plane figure; (2) it is bounded by one line, termed the circumference (3); every point of the circumference is at the same distance from a fixed point, termed the centre.

After the definition is worded in its permanent form, and repeated, and written several times on paper, it will be remembered.

Again, let us suppose the propositions on the equality of triangles to be the subject; the following introductory questions and exercises suggest themselves. Draw two straight lines, one 5 in. long, and the other 8 in.; then make with your protractor an angle of 43°. Construct a triangle having one of its angles equal to the angle drawn, and the sides of this angle equal to the given straight lines. Take the figures drawn by different boys, and compare them as regards size. Now consider the parts of each; how many sides has each? How many angles? How many sides are drawn from given dimensions? Letter them and then name them. How many angles? Name it. How many angles were not originally given? Name them. How many sides? Name it. Compare this third side, B C, in two of the figures. If the figures are all accurately drawn throughout the class, what must necessarily follow with regard to this third side B C in all the figures, &c.?

Finally, the proposition should be enunciated, and the proof learnt in the form in which it is to be remembered.

Then the teacher may give three angles which may form the angles of a triangle, and when the constructions are made compare two figures from distant parts of the class. Similarly he may treat all the allied propositions. When taught in this way, the subject becomes so easy and attractive that it may be commenced at an early age.

If, as some teachers maintain, Spartan severity be necessary to secure mental discipline, then this plan of teaching elementary geometry will not be an improvement on that of forcing into the memory Euclid, pure and simple, without note or comment; but when the test of success is applied, I am sure the plan of making the early school work as easy and as pleasant as possible will require no other argument to support it. R. WORMELL

Deschanel's "Heat"

IT is remarkable that Prof. Everett asserts h to represent the reduced height of the mercurial column, when the *unreduced* height is carefully indicated in Fig. 264 by the same symbol h. Moreover it is distinctly stated on page 362 that "the tension of the vapour is evidently equal to the external pressure minus *the height of the mercury in the tube.*"

Prof. Everett writes, "In some instances I have endeavoured to simplify the reasonings by which propositions are established or formulæ deduced" (Preface, part 1). This would lead most people to expect simplicity, which includes accuracy; and they may well be astounded when they find not only unexplained but inaccurate formulæ. Prof. Everett's promises, and not his complaint, were the grounds of expectations which have not been realised.

THE REVIEWER OF DESCHANEL'S "HEAT"

Sept. 22

Newspaper Science

MR. FORBES does not stand alone in his experience of newspaper science. The *Globe*, however, is not generally looked on as a scientific paper, and no one would be likely to go to it for information on matters other than political. What shall we say, however, to the following paragraph, copied *verbatim et literatim* from the columns of the *Mark Lane Express* for September 4?—

"CHARLOCK.—A correspondent inquires what he must do to abate the annoyance of it in his crops. We do not believe there is any mode of preventing its presence. Some seasons are distinguished by its appearance. We do not think they come from seed, but is the result of some electrical action producing them spontaneously. The late Duke of Portland used to say they need not sow white clover where bones were used freely; and where the pure white lime is used, clovers are seen without sowing seed. Also, if, as may be seen any season on the roads of Derbyshire, where the roads are repaired with white limestone, the clovers are present by the side of the wheel-tracks. The same may be seen on laying land down to permanent grass. Use farmyard manures, and the coarser grasses are seen; use road-scrapings and compost, and the finer grasses are sure to come. The charlock is an unwelcome visitor; but its removal in corn crops is often worse than the evil itself. 'Let both grow together till the time of harvest.' The seed has more value than some suppose, and when crushed will be found a good tonic. Nothing is given to us in vain."

Comment in this case also is needless. One hardly knows which most to admire in this rich paragraph; the independence of the trammels of the ordinary rules of syntax displayed by the writer; the teleological moral drawn at the end; or the contempt for science manifested in the assertion of the possibility of so highly-organised a plant as the charlock arising "spontaneously" in the ground. When such lamentable ignorance of the very elements of science is displayed by those who should be the leaders, what can we expect from the farmers themselves? Well may we exclaim, *Quis docebit ipsos doctores!*

ALFRED W. BENNETT

London, Sep. 23

ICE FLEAS

THE water flea, *Daphne pulex*, is a well-known inhabitant of rivers and fresh-water lakes, and, being distinctly visible to the naked eye, often attracts the attention of water drinkers. Though a harmless crustacean, this little creature not only excited great interest in parliamentary committees during the last session, but exercised a very powerful influence over the choice of a water supply for the northern capital of Great Britain. The ice flea, if known at all, is certainly less celebrated, and probably by no means likely to be so potent in its parliamentary influence; nevertheless a short account of it may not be wholly uninteresting to the readers of NATURE.

During a recent ramble upon the Morteratsch Glacier, I turned over some of the isolated stones which lie upon its surface partially imbedded in the ice; under many of them I found hundreds of a minute jet black insect, which jumped many times its own length at a single spring, in a manner somewhat resembling the performance of a common flea.* The ice flea is about one-twelfth of an inch long. Viewed through a pocket lens, it was seen to have six legs, supporting a body obscurely jointed like that of a bee, and furnished with two jointed antennæ. The total length of the insect appeared to be about six times its thickness, the antennæ being about one-fourth as long as the body. The insects were not found under every stone, they generally occurred under flattish fragments of rock, presenting a surface of about a square foot, and having a thickness of from 2 to 4 inches. Stones of this size are sufficiently warmed by the sun's rays to melt the ice beneath them more rapidly than it is liquefied by the direct solar beams. A surface of rock absorbs luminous thermal rays better than does a surface of comparatively white ice, and it transmits these rays to the ice beneath it, partly by conduction and partly by radiation from its under surface. The stone thus melts its way an inch or two deep into the ice, forming for itself a kind of basin. Sometimes these cavities are watertight, and then any space between the stone and the walls of its basin are filled with water derived from the melting ice. Under such conditions I have never found any fleas beneath the stone. But occasionally the ice basin is drained, and it was under stones resting in such comparatively dry basins that the insects were found. In all cases nearly the whole of the fleas were found upon the ice, very few being attached to the stones. They were grouped together in shoals, so that probably forty or fifty of them frequently rested upon a single square inch of ice. On removing the stones, the insects were very lively, but this might be owing to their sudden transition from comparative darkness to direct sunlight.

I saw no indications of food of any kind beneath the stones, indeed these insects must have a struggle for existence of a most severe character. Living in an atmosphere the temperature of which never rises above the freezing point, they must be continually exposed to inundations during the day by the stoppage of the drainage of the ice basin, whilst on clear nights severe frosts frequently threaten them with an icy grave. Again, during the day the roof of their habitation is, as it were, continually falling in upon them, and thus constantly exposing them to the risk of being crushed to death; for, as the ice melts beneath the stone, the latter is continually changing its points of support. It may be, however, that the crystalline structure of the ice causes it to melt with a corrugated surface, which provides everywhere valleys of sufficient depth to protect the fleas from destruction by the fall of the superincumbent mass of rock. We have also not to search far for a possible source of food. The cold of the glacier benumbs and kills thousands of insects which alight upon its surface, and bees, wasps, flies, and moths are frequently seen dead upon the ice. Then there is the so-called "red snow," and other allied organisms of similar habits, which may perhaps minister to the wants of this singular insect. Is the ice flea, like its irritating cousin, a nocturnal predatory insect, and does it issue from its dangerous abode at nightfall in search of frozen bees and butterflies? Perhaps some of the entomological readers of NATURE may be already acquainted with this animal, and be able to supply further information respecting it.

E. FRANKLAND

* My friend Prof. Eschenburg, of Zürich, had previously observed these insects on the Morteratsch Glacier, and it was his verbal account of them that led me to search for them.

REMARKS ON PROF. WILLIAMSON'S NEW CLASSIFICATION OF THE VASCULAR CRYPTOGAMS

IN discussing the points at issue between Prof. Williamson and myself, it will be necessary for me to say a few words on stems in general, because we evidently have very different views of the construction of stems; and until we thoroughly understand each other, it is impossible for us to come to any definite conclusions. In a young dicotyledonous stem (see Oliver's "Lessons," p. 112, fig. 67) we find three things: a quantity of cellular tissue surrounded by an epidermis, and near the centre a series of young fibro-vascular bundles. As growth goes on, these separate bundles coalesce and form a central cylinder of united fibro-vascular bundles. These bundles leave a portion of the cellular tissue in the middle of the stem, which becomes the pith. Outside the fibro-vascular bundles we have also a small quantity of the cellular tissue, but it soon becomes to a great extent inseparable from the sub-epidermal cells. Other portions of the cellular tissue remain between the united fibro-vascular bundles, and form the medullary rays. In many stems and in most roots these rays are wanting, and the cellular tissue would therefore be divided into two portions by the united bundles. Each fibro-vascular bundle consists of two portions, which are separated by a layer of cells capable of division, the cambium. On the inner side of the cambium cells we have in general spiral vessels, porous vessels, and wood cells, while on the outer side we have the soft bast and bast fibres. The epidermis is soon thrown off in many cases, and is replaced by layers of cork-cells or peculiar thickened bast-fibre-like cells from underneath. The stem thus consists of three sets of tissues: (1) the limitary tissues, including epidermis, periderm, &c.; (2) the fibro-vascular bundles; and (3) the primitive tissue or *Grundgewebe* of Sachs (see "Mo. Mic. Journal," vol. iii. p. 160). In an older dicotyledonous stem we find the limitary tissues becoming largely developed, cork-cambium and layers of cork being formed. The fibro-vascular bundles have also largely developed, the cambium cells by division, and the conversion of these new cells into permanent tissue has formed a number of annual rings of wood-cells and vessels as well as layers of bast, while the primitive tissue only increases very slowly in the medullary rays, the pith not increasing, and the primitive tissue under the epidermis becoming lost in the rapidly-developing bark. Such is the structure of a dicotyledonous stem.

In a monocotyledon we have the same tissues, limitary, fibro-vascular, and primitive. The primitive tissue is largely developed, forming the cellular tissue by which the fibro-vascular bundles are surrounded (Oliver, "Lessons," p. 113, fig. 68). These fibro-vascular bundles differ quite as much in the nature of their cells and vessels as those of the dicotyledon, often one form being developed in excess of the other. The limitary tissues also develop cork and other cells. There is thus very little difficulty in comparing a very young dicotyledonous stem with that of a monocotyledon. In the monocotyledons the fibro-vascular bundles are closed, and therefore no annual layers are found; but in such stems as Dracæna, Aloe, Yucca, &c., we have the stem increasing in diameter. The outer cells of the primitive tissue divide and form not only new primitive tissue but new fibro-vascular bundles (Sachs, "Lehrbuch der Botanik," ed. 2, p. 103, fig. 90). Prof. Williamson would probably call these Exogenous Endogens.

When we come to the Lycopod and Fern stem, we find the same parts—limitary tissues, fibro-vascular bundles, and primitive tissue. In ferns the bundles are more or less scattered, like those of the monocotyledon, while in the Lycopods we either have them separate or else all joined together to form a central axis (see Sachs, *op. cit.*, figs. 66 and 89). Round this central axis in Lycopods we have the primitive tissue, while outside we have the epidermis often with peculiar thickened cells underneath, forming part of the limitary tissues. In Mosses, Charas, and Thallophytes we have only the primitive and limitary tissues, the fibro-vascular bundles being entirely absent. In some of the Thallophytes, however, as in Lessonia, we may have the primitive tissue increasing just as in Dracæna.

In Lepidodendron, as in some of our modern Lycopods, we have a central axis of combined fibro-vascular bundles, and a large quantity of primitive tissue, no longer all parenchymatous, as in many of our recent Lycopods, but mostly prosenchymatous, as in *L. chamæcyparissus*. This primitive tissue went on increasing year after year, new cells forming by division, these being soon changed into hard prosenchymatous cells. Outside we have the limitary tissue strengthened, as in some of our recent species, by remarkable prosenchymatous cells. In Lepidodendron the primitive tissue was capable of dividing in the same way as that of Dracæna. The stem increased year after year, not by growth of the wood-cells, &c., of the fibro-vascular bundles, as in a dicotyledonous stem, but by additions to the primitive tissue. I never denied that the Lepidodendron stem increased in diameter, but pointed out that the increase takes place by multiplication of the cells near the periphery of the primitive tissue, the portion not likely to be often preserved in Lepidodrendon stems. This mode of growth is quite compatible with the statement that the fibro-vascular bundles are closed as they are both in Ferns and Lycopods. As Prof. Williamson admits that "the large vascular cylinder of the fossil forms is a development of what is seen not only in *Lycopodium chamæcyparissus*, but in every one of the numerous Lycopods of which I have examined sections," there is no difficulty in settling the matter. The cylinder in *L. chamæcyparissus* is part of the primitive tissue, not of the fibro-vascular bundles. Such being the case, the central axis of Lepidodendron is not a "vascular medulla," but a series of closed fibro-vascular bundles. In Lepidodendron we have merely a pseudo-exogenous growth taking place in the primitive tissue, while in Gymnosperms and Dicotyledons we have true exogenous growth in the fibro-vascular bundles. In Ferns this pseudo-exogenous growth is not likely to take place, as a fern produces only a few large leaves, while in a Lycopod or Lepidodrendron, which produces numerous small leaves, water for purposes of transpiration would have to be rapidly supplied in yearly increasing quantities. This is provided for by the increase which takes place in the wood-cells of the primitive tissue, not as in Dicotyledons, by additions to the wood-cells of the fibro-vascular bundles. Prof. Williamson has been led away by the mere superficial resemblance of the parts, and has never tried to understand the homologies of these stems. He has mistaken the united closed fibro-vascular bundles in the centre of the stem for a vascular medulla, *i.e.*, for a portion of the primitive tissue; and he has mistaken the woody cylinder surrounding this—which is a modified portion of the primitive tissue—for the united fibro-vascular bundles of a dicotyledon. After making two such fatal errors, can his proposed new classification be considered of any value?

W. R. M'NAB

A NEW DYNAMETER

IT need not be said that in astronomical observation it is always desirable, to say the least of it, to have a tolerably correct estimate of the magnifying power actually in use. This has hitherto been only attainable either by means of the maker's valuation, or through the employment of the apparatus unfortunately termed a "dynameter," a word which every classical scholar would wish to see as soon as possible dismissed from circulation. The former alternative is, I am sorry to say, often far from reliable; the latter involves an outlay not within the reach of every astronomical student. The Rev. E. L. Berthon, Vicar of Romsey, Hants, well known already for many ingenious and valuable inventions, has recently devised a little apparatus for attaining the same object, which deserves high commendation. Its very moderate price places it within the reach of all; and its accuracy appears equal to that of instruments of more complicated construction and higher pretension. I have heard on excellent authority that very little dependence can be placed on the estimates of magnifying powers too frequently furnished to purchasers. Eyepieces are both constructed and rated too frequently by "rule of thumb," and their real, if measured, will be found widely different from their nominal power. Some opticians, as, for instance, the celebrated reflector-maker Short, have had an unfortunate reputation for exaggerating the power of their instruments, and without any suspicion of misrepresentation: such has been the case even at the celebrated Optical Institute of Munich, as appears by the corrections made by W. Struve in the numerical values of the Dorpat oculars, 94, 140, 214, 320, 480, 600, 800, 1,000, 1,500, 2,000, being respectively lowered by him on trial to 86, 133, 198, 254, 420, 532, 682, 848, 1,150, 1,500. In this instance, it is possible that some different mode of measurement may have led to the discrepancy. Uncertainty, it may be suspected, occasionally arises from this cause. I once undertook, at the special request of a friend, to verify with a double-image dynameter the power of some oculars constructed by a very eminent optician, whose name was an abundant guarantee for his good faith; but the results, on which I bestowed a great deal of care and trouble, trusting only to averages of many repeated measures, did not agree satisfactorily with the maker's statement. I do not know whether it may have been generally noticed, but the remark is a very obvious one, that the limit of numerical error increases with the power, so that in the case at any rate of ordinary dynameters, minute accuracy in the estimates of very deep oculars bears evidence of its own futility. If it represents anything of value, it can only be the care and attention with which a mean was deduced from repeated trials; but even this would be better expressed in round numbers, as less likely to convey an erroneous impression to the uninitiated.

Probably some form of apparatus may yet be devised which may secure greater minuteness in the measurement of very high powers, without entailing a disproportionate outlay. In the mean time Mr. Berthon's invention may be safely recommended as likely to prove of especial advantage to observers in general.

T. W. WEBB

THE NEW GANOID FISH (CERATODUS) RECENTLY DISCOVERED IN QUEENSLAND

II.

IT appears to me that there is not the least justification for separating the living fish *generically* from that extinct form, the teeth of which are known by the name of *Ceratodus*. Immediately after its discovery became known, and before we knew more than the outlines of its external characters, views to the contrary were expressed, evidently based on the assumption that a genus was not likely to have survived from the Triassic epoch. This is certainly a remarkable fact, but it is not more surprising than the other, viz., that fishes from one of the oldest epochs from which fish remains are known, are most closely allied to *Ceratodus*. We know that the same *species* occur on both sides of the Central-American isthmus—that is, that they have existed at, and remained unchanged from, the time when the Pacific and Atlantic Oceans were connected by one or several channels. Therefore, it would appear that there is a greater persistence in the ichthyic type than we have hitherto been willing to admit.

Whoever has compared the teeth of *Ceratodus runcinatus* from the German Muschel-Kalk, and those of the Indian species described by Prof. Oldham, with the teeth of the living species, must admit their generic identity; and if the Australian form really grows to the enormous size stated by some colonists, I have no doubt that the teeth of such large examples cannot be distinguished from the fossils mentioned. So close a resemblance in highly specialised teeth like those of *Ceratodus* is generally admitted to be of generic significance. Unfortunately no other part of *Ceratodus* is known to have been preserved in the fossil state to serve as a further guide in answering this question. The strata in which the teeth are found must have been much disturbed, as no two teeth have ever been met with *in situ* together; but I cannot help thinking that sooner or later the vomerine teeth will be recognised. From their smaller size they would easily have escaped observation; and their shape (which differs so much from that of the molars) would scarcely have allowed an observer to connect them with the genus to which they in reality belong.

The next most nearly allied forms are the American and African *Lepidosirens*, a genus at present unknown in a fossil state. The skeleton (in some respects even to its minute details), structure of the fins, dentition, internal nostrils, three-chambered heart, co-existence of a lung with gills, intestinal tract, small size of ova: all present the strongest possible evidence of the close relationship between these fishes. The points in which they differ are of such a nature that characters indicative of an amphibian affinity in *Lepidosiren* are modified in *Ceratodus* according to a distinctly ichthyic type, thus tying, as it were, *Lepidosiren* firmly to the class of fishes. The longitudinal valves in the bulbus arteriosus of *Lepidosiren*, reminding us of a similar structure in the heart of Batrachians, are replaced by truly Ganoid valves in *Ceratodus*; the imperfect gills of the former genus are as perfect in the latter as in any other fish; the lungs of *Lepidosiren*, paired as in a frog, are confluent into a single air-bladder-like sac in the Australian form; instead of the closed ovaries with a developed oviduct and fallopian tubes of *Lepidosiren*, we find the ovaries of the Barramunda open, discharging the ova into the abdominal cavity, as in the Salmon family and other fishes. These differential characters may be considered by some of sufficient importance to refer the *Lepidosirens* and the Barramunda to two distinct groups.

Some of the oldest fishes, known from the Devonian epoch, are designated by the names *Ctenodus* and *Dipterus*. Whether they should be referred to one genus or two is a question about which opinions are divided, and into which I need not enter here. They are evidently representatives of the same ichthyic type as the Dipnoi of the present epoch. The similarity of the large molars to those of *Ceratodus* has been recognised for a long time; but it is only recently that I have been able to ascertain, in an example in the Jermyn Street Museum, the presence of a pair of small vomerine teeth. Moreover, the same example presents as good evidence as we can expect in a fossil, that the nostrils are placed within the mouth. These characters are combined with the presence of acutely lobed paddles, and of a notochordal skeleton; but there is the great difference that the end of the vertebral column is heterocercal, instead of being diphyocercal, as in *Lepidosiren* and *Ceratodus*. Therefore *Ctenodus* will form the type of a distinct dipnöous family.

Thus, then, we arrive at the conclusion that *Lepidosiren*, far from being an isolated representative of a distinct subclass of fishes, is only one of the representatives of a suborder of Ganoid fishes, characterised by the position of the nostrils within the mouth, by paddles supported by a jointed axis, by lungs co-existent with gills, by a notochordal skeleton, and by the absence of branchiostegals. The term "Dipnoi" may be retained for this sub-order, which was developed in the earliest epochs from which fish-remains are known, while we have scanty evidence of its presence in Liassic and Triassic strata, and, in the present state of our knowledge, it appears to be lost, until we find it again represented by three living forms in the present period. Probably some other extinct genera belonged also to this sub-order, but their remains are in too fragmentary a condition to admit of an exact definition of their affinities.

During the examination of *Ceratodus*, I had so frequently occasion to refer to structural peculiarities of the *Plagiostomata* (Sharks and Rays), that I was induced to reconsider the relations existing between this sub-class and the Ganoid and Teleosteous fishes; and I came to the conclusion that the two former are much more nearly allied to each other than the Ganoids are to the Teleostei. The Plagiostomes were considered to be a distinct sub-class of fishes on account of the highly-developed state of the organs of reproduction in the female, besides the presence of copulatory organs in the male. Their ova are different from those of other fishes, having a very peculiar shape, and shell with adhesive appendages, and being of an unusually large size, and few in number. They are impregnated internally; some of the species are viviparous. They have from five to seven external gill-openings. Although in external appearance a Ray and a Shark are apparently very different, yet these extremes are connected by a number of intermediate forms, and they form altogether one of the most homogeneous groups in the zoological system.

On the other hand they agree with the Ganoids in having, in addition to the ordinary two divisions of the fish-heart, a third contractile chamber. This bulbus arteriosus is very different from the *Bulbus aortæ* of the Teleosteous fishes, where it is simply a swelling of the walls of the aorta, not contractile, without valves in the interior, and separated from the heart by two valves opposite to each other. If this remarkable arrangement is deemed (and, I think, very justly) to be sufficient to separate the living Ganoids as a sub-class from the *Teleostei*, it is certainly significant enough to suggest the union of the Ganoids with the Plagiostomes. Moreover, this character is supported by two others of great importance, viz., the presence of a spiral valve in the intestine, which is found in a more or less developed state in all Ganoids, Sharks, and Rays, but is entirely absent, even in a rudimentary condition, in the Teleostei, and by the optic nerves being placed side by side, and not decussating, as is the case in all our ordinary fishes. Of the characters connecting these fishes I will refer to one other, as it has been described above, namely, that the fore and hind limbs of the Plagiostomes are also paddles supported by a cartilaginous structure, as in the *Dipnoi*.

The evidence in favour of a union of Ganoids with Plagiostomes is rendered complete by the Chimæras, which hold a surprisingly intermediate position. They are Sharks in external appearance and with regard to the structure of their organs of propagation; they are provided with the same copulatory organs, and their ova are large, enclosed in a horny case, and provided with adhesive appendages. Many species of Sharks, when in a very young state, are provided with a double dorsal series of spines (permanent in certain Rays), which are lost with age; and this most remarkable developmental character occurs likewise in young Chimæras. On the other hand, there is only one external gill-opening on each side, as, for instance, in *Ceratodus*, which, on the other hand, shows the first step towards a coalescence of the gills with the walls of the gill-cavity. The skeleton is notochordal, and the palatal and maxillary apparatus coalesce with the skull, as in *Dipnoi*, which is not the case in any Plagiostome; likewise the dentition approaches that of *Ceratodus*. Finally, Sir P. Egerton has drawn attention to the most important fact that the dorsal spine is articulated to a neural apophysis, and not merely implanted in the soft parts and immovable, as in Sharks.

Thus, then, the union of these fishes in one sub-class appears to me fully justified, as far as the living forms are concerned; but, as is implied by the name *Palæichthyes*, which I have proposed for this sub-class, it is intended to comprise also a great variety of forms from the Palæozoic Era, in fact, the predecessors of the Teleostean fish-fauna of the present period. I am aware of the objections that may be urged. First, it may appear to some to be an improper proceeding to unite in the same sub-class fishes of so different an appearance as a Shark and Lepidosiren, or as an Amia and a Pteraspis; but let them consider what a comprehensive category a sub-class necessarily is—that the diversity between the fishes just named is not greater than that existing between a Sun-fish (*Orthagoriscus*) and an eel, or between a viviparous Embiotoca and a Loricaria, forms admitted by every ichthyologist of the present day as members of the same sub-class, that of Teleosteans. In fact the Palæichthyes are composed of a similar series of modifications as the Teleosteans, some of the members of one sub-class exhibiting marked analogies with those of the other, in the same manner as is the case with Placentalia and Implacentalia among mammals. To mix up ganoid-looking Teleosteans, like the Siluroids, with Ganoids, is as little in accordance with the advanced state of our ichthyological knowledge, as the union of Salamandra with Lacerta would be. Secondly, other naturalists may consider it very hazardous to establish a division, of which the majority of members are extinct and known from remains of the hard parts only, and to characterise it by peculiarities of the soft parts. But why should we not make use of zoological evidence for the completion of the imperfect palæontological record, with the same benefit to science as in other cases, since not a few zoological problems have been, or can only be, solved by reasoning founded on palæontological facts? If, in the determination of affinities, we were to limit ourselves only to the consideration of those parts which have been preserved in the process of fossilisation, we could never expect any other result but the creation of most artificial assemblages of forms, although the characters of some natural families, or even orders, might be partly recognised.

On the one hand, we know that all the Teleosteous fishes, that is, the types which are predominant in the present and next preceding epochs, and which were but sparingly (*Coccosteus?*) represented in the Palæozoic, if they existed at all, agree, in spite of all other differences, with one another in possessing a two-chambered heart, with a rigid bulbus aortæ and decussating optic nerves, and in never exhibiting a trace of a spiral valve in the intestine.* On the other hand, we find that the few ichthyic types which have survived from the Palæozoic Era into our period, and those of which no immediate representative is known in that Era, but which approach that Amphibian fish-type by unmistakeable characters, agree, in spite of all other differences, in having a three-chambered heart, non-decussating optic nerves, and a spiral valve in the intestine. These are facts; and it seems to be a fair conclusion that the members of the Palæozoic fish-fauna had essentially the same organisation of those soft parts as their surviving representatives.

In conclusion I may shortly pass in review the living *Palæichthyes*, especially in regard to their distribution over the globe.

1. Of the order *Plagiostomata* or *Marine Palæichthyes*, 140 species of Sharks, distributed among 39 genera, are known, and 150 species of Rays, belonging to 25 genera. They inhabit nearly all the seas of the globe, decreasing in number from the tropics towards the poles. Only very few enter or live in freshwater.

2. The order *Holocephala* contains only four species, viz., three Chimæras and one Callocephalus; they are restricted to the seas of the temperate zones of both hemispheres, and are absent between the tropics.

3. The order *Ganoidei* or *Freshwater Palæichthyes* is represented by one species of *Amia*, from North America; three species of *Lepidosteus*, from the same region, but extending southwards into Central America and Cuba; two species of *Polypterus* (*Calamoichthys*) from the tropical parts of Africa; two species of *Polyodon*, from the Mississippi and the Yantsekiang; about twenty-five Sturgeons, from the temperate and sub-arctic regions of the Northern Hemisphere; two species of *Ceratodus* from tropical Australia; one species of *Lepidosiren* from the Amazon river, and one of *Protopterus* from tropical Africa. Although the majority of the Sturgeons pass a part of the year in the sea, they must be regarded as freshwater fishes like the migratory Salmones, because they deposit their spawn in the rivers, where they also pass the first period of their growth; some species never enter the sea at any period of their life, and none are known to propagate in the sea.

The total number of fishes known at present being about 9,000, the *Palæichthyes* form only 3·6 per cent. of that number. But from the extent of the regions hitherto ichthyologically unexplored, and from the numerous additions annually made to the list of known forms, I do not believe that we are acquainted with much more than one-tenth of the species of fishes actually existing.

ALBERT GÜNTHER

* From these considerations *Amphioxus* and the *Marsipobranchii* are excluded, the former being evidently the type of a distinct sub-class.

METEOROLOGY IN AMERICA *

III.—SELF-REGISTERING INSTRUMENTS

INVALUABLE as is the ordinary barometer, the most valuable instruments are those which are automatic, or self-registering. Prominent among those used in America are the Self-recording Barometer and Meteorograph invented by Prof. G. W. Hough, Superintendent of the Dudley Observatory. Lord Rosse's telescope has not done more for astronomy than will the self-registering barometer do for meteorology.

The diagram, Fig. 7, will illustrate the method of registering the height of the barometer and thermometer on a single sheet, by the use of one set of mechanism in these simple yet complete and consummate contrivances.

Let D be a drum six inches in diameter and seven inches in height, covered with a sheet of ruled paper. This drum is presumed to revolve at any convenient rate, say one inch per day. Let L be an iron or brass bar twenty-four inches in length, mounted on an axis passing through the point *c*. Let P be a steel pen attached to the end of the lever projecting over the centre of the drum. Let P′ and P″ be platinum wires attached to the lever at three inches on either side of the axis *c*. The wire P′ is over the shorter leg of a siphon barometer, and the wire P″ passes into the end of an open mercury thermometer.

Now if the lever L be elevated at the end over the drum, the wire P′ will touch the top of a float resting in the shorter leg of the siphon barometer If then a battery, B, and electro-magnet, E, be arranged as in the diagram, when contact is made with the float, a current of electricity will pass through the circuit, and the electro-magnet E is operated. If then, when the circuit is completed, a blow be struck on the pen P, by means of the electro-magnet, or a hammer unlocked by it, the dot on the drum sheet will indicate the height of the barometer at that time. It is obvious that as often as the lever is elevated a record will be made. For the barometer an hourly record will be found to be sufficient.

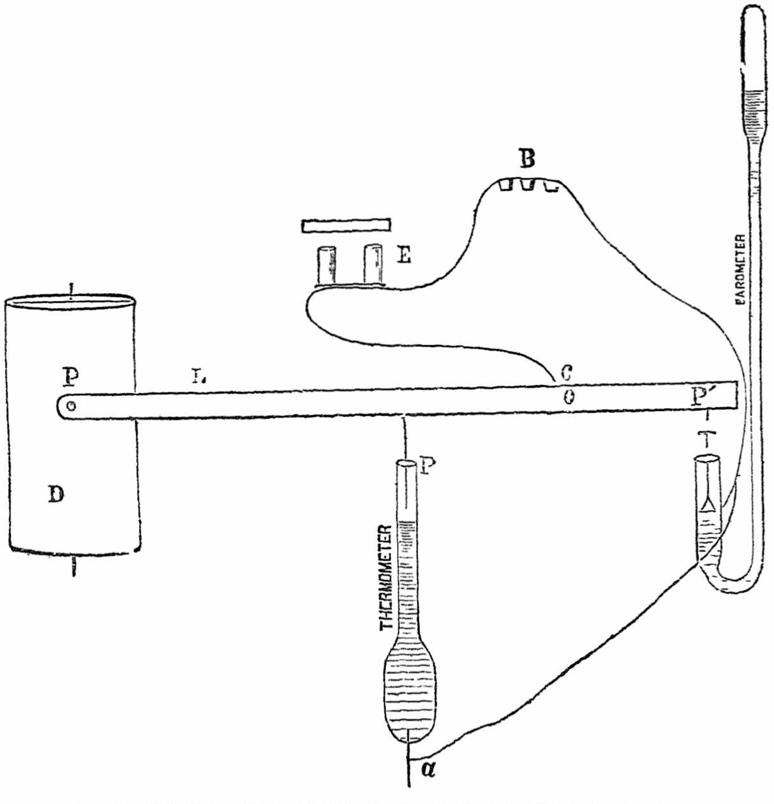

FIG. 7—REGISTRATION OF THE HEIGHT OF BAROMETER AND THERMOMETER

If the lever L is rigid and firmly mounted, the mere measurement of height by means of electrical contact can be carried to almost any degree of precision.

It was found from numerous experiments made some years since, that the magnetic circuit is not completed for a distance of one ten-thousandth of an inch. Therefore, whatever source of error there may be in the results recorded by this method is due to the barometer itself. In practice, from records extending over nearly one year, it is found that the results are inside the errors of reading from the drum sheet.

A long experience has led to the conclusion that this degree of precision is sufficient for the investigation of barometric changes, and is but little outside the limit of error from reading a standard barometer.

An examination of the diagram will also show at a glance how the height of the thermometer is recorded. It should, however, previously be stated that the thermometer is a little larger than those in ordinary use, and has a platinum wire, *a*, cemented in the bulb, communicating with the mercury in the inside.

The following is a general description of a machine constructed for the Signal Service at the request of the chief signal officer.

It registers hourly the barometer and wet and dry bulb

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

thermometers, and thus shows the atmospheric pressure, the temperature of the atmosphere, and its hygrometric condition—*i.e.*, its condition of moisture or dryness.

The engraving, Fig. 8, is a perspective view of this instrument. The recording lever, A, is a bar of iron about two feet in length, nearly balanced on the axis, supported by the clock-frame, C. The clock is constructed with rather stronger gearing than an ordinary movement, its office being to elevate and depress the lever A hourly, regulate the drum, D, and raise the two striking hammers, H and H′. It is provided with a half-second pendulum, and requires winding once in two days, the weight dropping in that time about three feet.

The shorter leg of the siphon barometer is shown at B, and the wet and dry bulb thermometers at T′ and T. Directly over the leg of the siphon, as also over the two

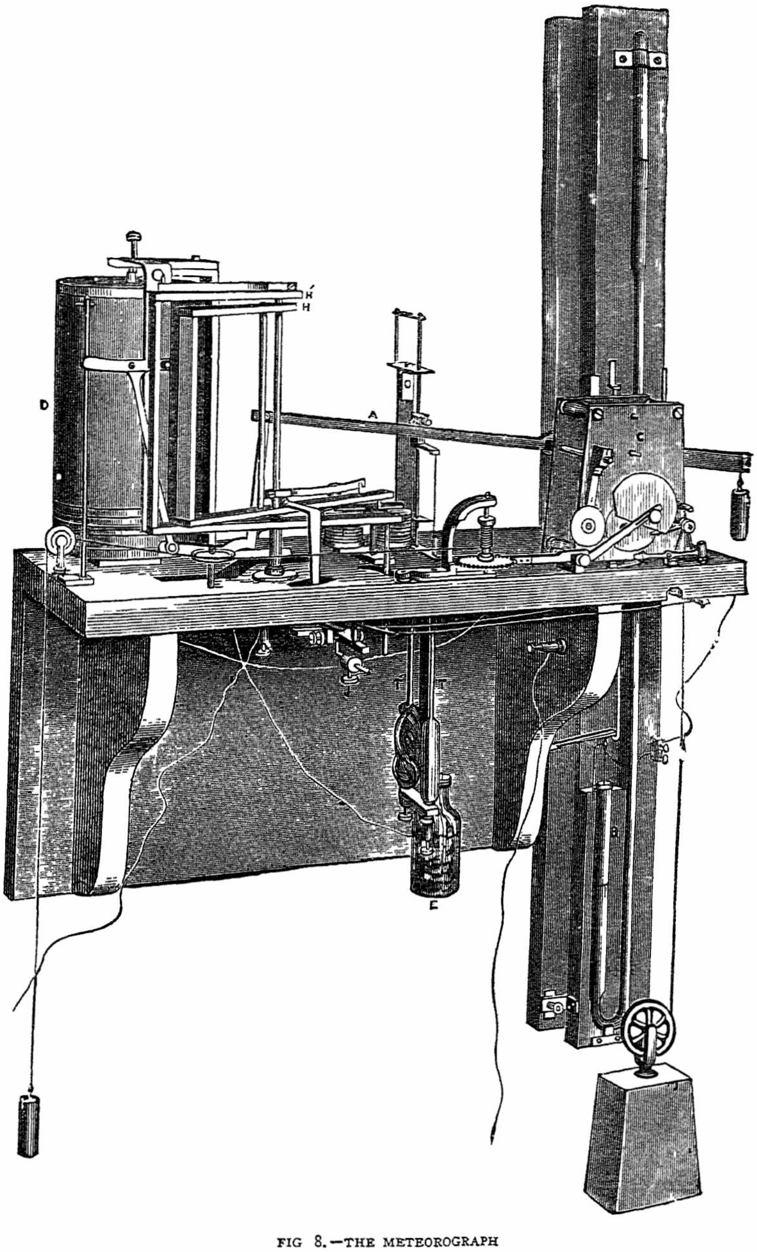

FIG 8.—THE METEOROGRAPH

thermometers, the lever A supports a carriage, which is depressed or elevated whenever the lever A is in motion. The registering point, G, is connected with the lever, as shown in the diagram; and the curvilinear motion of the end of the lever is converted into rectilinear by allowing G to slide against a vertical steel rod.

To illustrate the action of the machine, we will suppose the lever A has reached its lowest point, the registering pen G being at the bottom of the drum. Now, in order that we may be able to register the barometer on any part of the drum sheet, it is necessary that the striking hammer should be elevated and locked before the upward motion of the lever commences. As the hammers are raised by means of an arm carried by the hour shaft of the clock, at the point where the hammers begin to rise the snail for elevating the lever A is cut away, so that it remains at rest during a period of fifteen minutes, the time required for elevating the hammers H and H'. As soon as this is accomplished, the lever begins to rise slowly by means of the double snail on the hour shaft, the time required for traversing the drum being about fifteen minutes. When the position of the lever is such that the carriage in the rear of the clock touches the float in the shorter leg of the siphon, an electric current is established through the magnet, F, which unlocks the hammer H, causing the pen G to make a record on the drum sheet. After the lever has reached the top of the drum, it remains at rest fifteen minutes while the hammers are being raised, when it is gradually depressed. So soon as the platinum wires—attached to the carriage over the thermometers—touch the surface of the mercury in the thermometer tubes, electric currents are established through the magnets F and J, simultaneously or successively unlocking the hammers, and, as the case may be, making records as before.

A complete double motion of the lever requires one hour. During this time the barometer and wet and dry bulb thermometers have each been recorded once. The records of the barometer and thermometers differ in time about half an hour. The wet and dry bulb thermometers are recorded within about one minute of each other, depending on the difference between them.

One of the most marked and wonderful features of the invention of Prof. Hough is that it prints its own records. And this is done by a single screw, which rises or falls

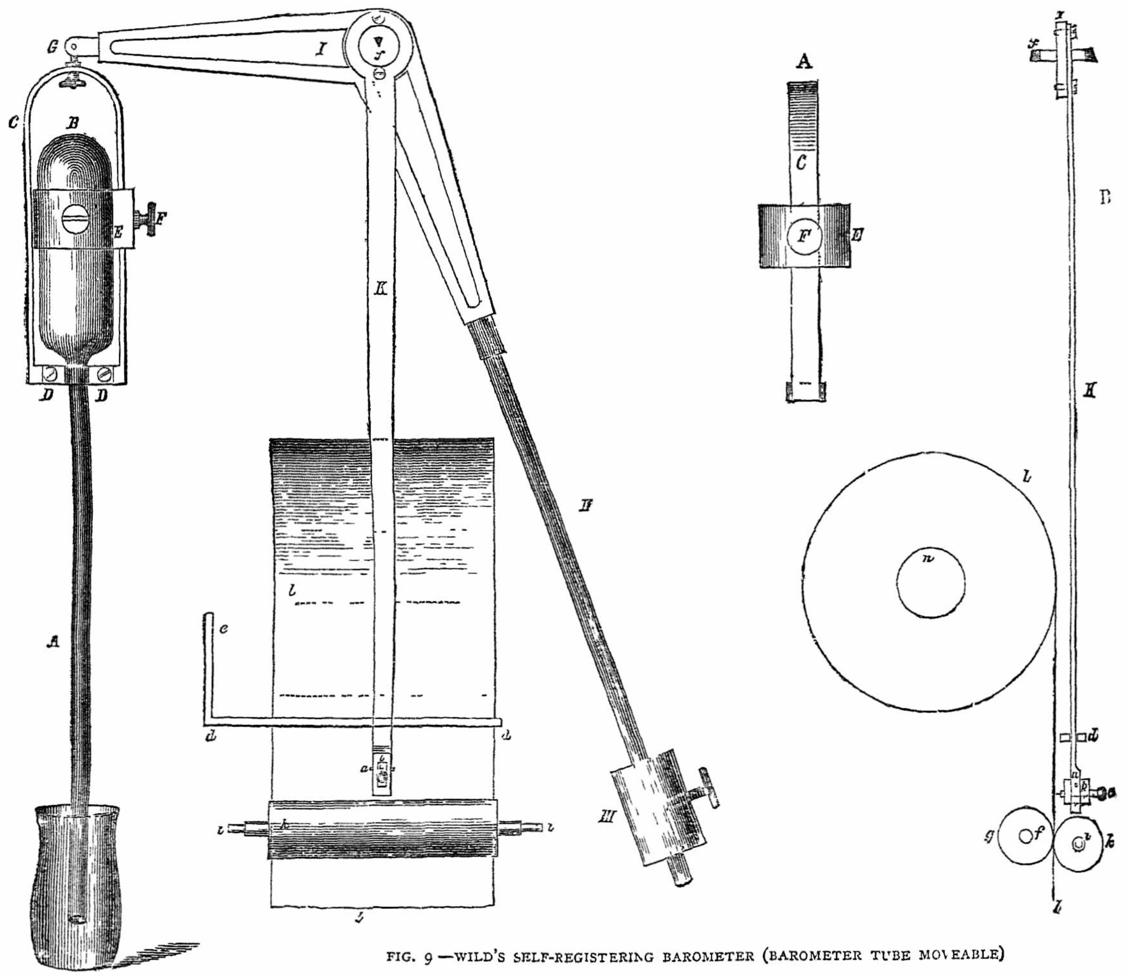

FIG. 9—WILD'S SELF-REGISTERING BAROMETER (BAROMETER TUBE MOVEABLE)

with the mercury in the barometer. This screw carries a pencil, which traces upon a revolving cylinder or roll of paper a line showing the minutest movements of the column of mercury for every minute in twenty-four hours. This same screw also gives motion to a series of wheels which carry types, by which, at the end of every hour, the height of the column of mercury is printed on a slip of paper to the accuracy of the *thousandth part of an inch!*

One of the most beautiful and simple contrivances used is a Wild's Self-registering Barometer, of which we give a cut one quarter the actual size. It scarcely needs explanation, except to say that the tube A is suspended in a cistern of mercury, represented on the left of Fig. 9. As the atmospheric pressure changes, the level of the mercury changes in the cistern, and the tube A rises or falls as the atmospheric pressure increases or diminishes. The weight of this tube as it floats in the mercury, and also that of the arm *I*, which supports it at *G*, is exactly balanced by the arm *II*, to which is attached a sliding weight, *III*, adjustable by a small thumb-screw. *K* is a steel crayon-holder fixed to the balance *I II*, and to which is fixed a crayon, *c*, whose point in seen in B to impinge upon a sheet of paper, *l l*. This sheet s moved by clock-work. When the atmospheric pressure is increased, the tube *A* is forced to rise a little out of the mercury in which it floats, and as it rises at *G*, the arm *I* is elevated. The crayon holder, being fixed on the balance at the fulcrum, *f*, by two little screws, swings a little to the left, and the crayon which it carries with it makes a mark on the paper beneath it, which mark indicates the rise of the barometer, or the increase of atmospheric pressure. If the pressure decreases, the pencil, of course, moves in the opposite direction, and shows the barometric fall. The roll of paper on which the record is made by this automatic instrument is divided into rectangular parts, each one of which exhibits the atmospheric variations for twenty-four hours. At the end of every day this part of the roll is detached and put by to be bound up in book form in the records of the office in which the instrument is kept.

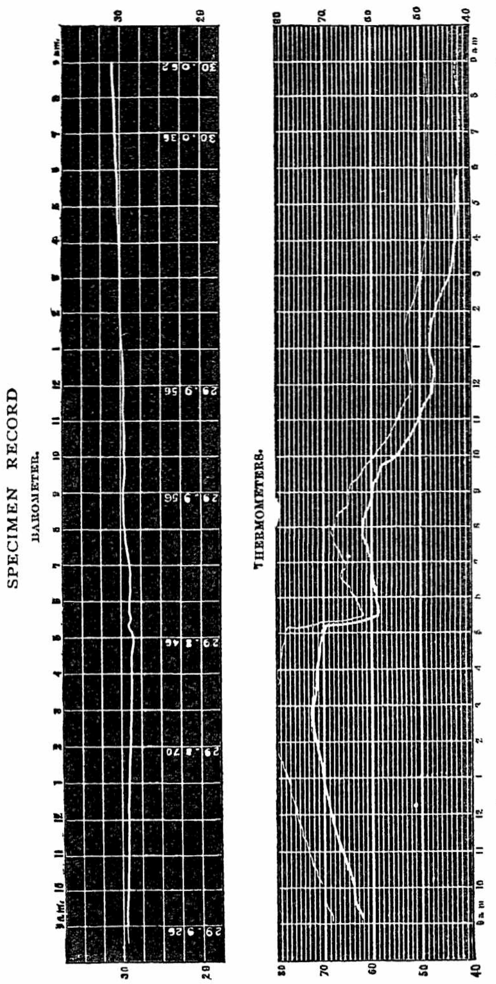

FIG. 10.—DRAPER'S PHOTOGRAPHIC REGISTER OF BAROMETER AND THERMOMETER AT NEW YORK, APRIL 28, 1871

The upper line of the Thermometer is the Dry Bulb, the lower line is the Wet Bulb

The roll of paper is on a reel, *n*, passing between two rollers, *g* and *k*, as seen in B (Fig. 9).

By these perfectly simple devices, instead of obtaining only three daily recorded observations, the observer at every station gets a continuous and perpetual record for every second in the day. That is to say, instead of getting, as by the common barometer (observed three times a day), observations for three seconds in twenty-four hours, he gets them for as many seconds as there are in twenty-four hours, or 86,400. Thus it follows that the value of the self-registering barometer, as compared with the ordinary one, is as 86,400 to 3 !

The marvellous accuracy and exquisite nicety with which all the observations forwarded to General Myer by the observers are marked ought to assure the public that nothing is wanting to give reliability to the published results and the "probabilities" issued from his officers. A self-registering barometer, as well as other instruments

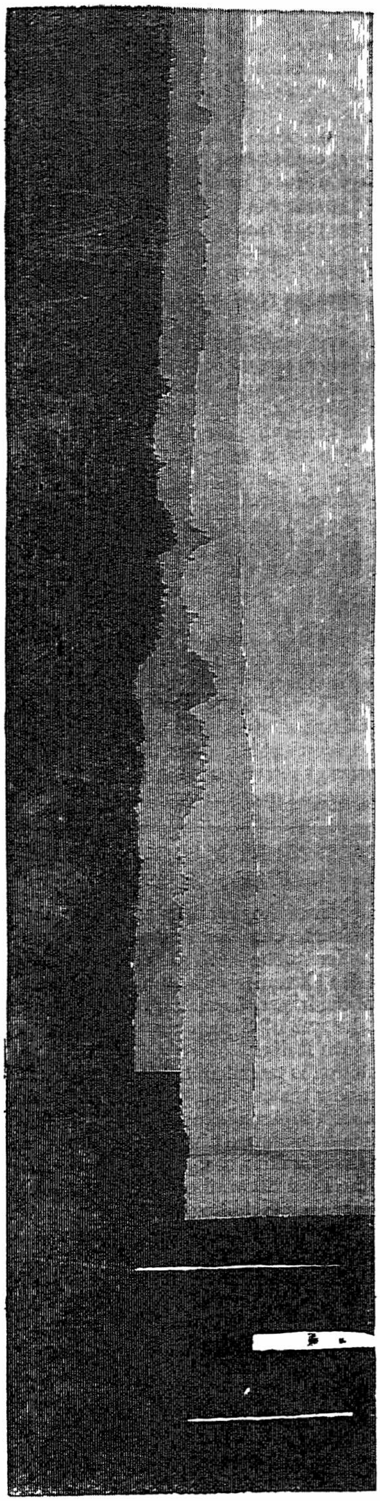

FIG 11.—PHOTOGRAPH OF A STORM.—(*Print from Photographic Register from Noon, December 11, 1870, half-inch per hour.*) *Two Thermometer and One Barometric Curve*

of equal sensitiveness, will be used by all the observer-sergeants. It is scarcely possible for this invaluable instrument to suffer derangement or to get out of order.

A third most beautiful and sensitive self-registering instrument is that of Mr. Peelor, of Johnstown, Pennsylvania, used with great success and satisfaction by the Signal Service. This needs no battery, no electricity, to work it. A simple clock-work is all that is required, and its operations are as exquisitely accurate and trustworthy as the best navy chronometer.

A barograph and thermograph made by Mr. Beck, of London, similar to those used in the Kew Observatory, are on trial in the Signal Office, and good results are hoped from them. Their beautiful machinery might also be mentioned and described, but our space fails. Indeed, our limits have allowed mention to be made only of the most novel instruments employed by the signal offices. A specimen record of one of these is presented in Fig. 10, showing the synchronous readings, on a given day and at a given place, of the thermometers (wet and dry bulb), the hygrometer, and the barometer, all upon one sheet of paper.

We have already spoken of the beautiful adaptation of Prof. Hough's Meteorograph to the work of printing its own registrations. The mechanics of meteorology have been advanced one step higher than this, and the registrations of the automaton are instantly and perfectly photographed. The sheet of paper, suitably prepared for photographic impressions, is made to slide, by means of clock-work, before a gas flame. The mercury in the tubes protects a portion of the paper from the action of the light of the lamp, while above the mercury the rays of the lamp fall unobstructed upon the paper, and, making their impression, reveal the exact height of the mercury in the tubes.

The "photograph of a storm," Fig. 11, shows the movements of the mercury in the two thermometers and barometer for twelve hours.

This process, by which the weather is photographed, is employed by General Myer, and these necessarily exact records will prove most attractive pictorial representations of the great storms in the atmospheric ocean for the study of meteorologists all over the world.

THE INTERNATIONAL EXHIBITION AT VIENNA FOR 1873

THE Emperor of Austria has appointed an Imperial Commission to carry out the project of an International Exhibition to be held at Vienna in 1873. The members of the Commission held their inaugural meeting in the hall of the Imperial Academy of Sciences at Vienna on Sunday, the 17th of September, under the presidency of the Archduke Rainer.

The Exhibition is intended to be opened on the 1st of May, 1873, under the especial patronage of the Emperor and his brother, the Archduke Charles Louis. The Commission, which is composed after the models of the English and French Commissions, consists of the Archduke Rainer, president; the Lord Steward of the Imperial Household, Prince zu Hohenlohe-Schillingsfürst; the Imperial Chancellor, Minister of the Imperial House and for Foreign Affairs, Count von Beust; Prince zu Liechtenstein. Prince Schwarzenberg, Count Festetitz, and Count Potocki, vice-presidents; and the Lord High Chamberlain, Count Folliot de Crenneville, and other high courtiers, the Ministers and heads of departments, the Presidents of both Houses of the Reichsrath, the presidents of the chief artistic, commercial, and scientific societies, and a number of gentlemen who have distinguished themselves in the various branches of science, art, and industry.

The entire arrangements have been entrusted to the Austrian Consul-General at Paris, Privy Councillor Baron de Schwarz-Senborn, who has been nominated Director-General of the Exhibition. Local committees are about to be formed in the various provinces of Austria and Hungary, and a special Royal Commission is to be appointed at Pesth. The objects to be exhibited will be classified into 26 different groups, as detailed in the subjoined programme.

One great feature of the Exhibition will be an arrangement for the classification of the productions of all countries in groups corresponding with their geographical position, and great pains will be taken to render the Oriental department in every way worthy of the almost inexhaustible resources of the Indian Empire. The position of Vienna is admirably adapted for this, having, besides the waters of the Danube, a direct communication with all the important harbours of the Levant *viâ* Trieste. The arrangement of the Eastern department will be confided to the Austrian Consul at Constantinople, Dr. de Schwegel, who has already acquired a great reputation for his knowledge of Oriental habits and productions.

A new feature of the Exhibition will be an arrangement by which the treasured collections of the various museums of London, Paris, Berlin, Moscow, Lyons, Munich, Stuttgard, &c., will appear in simultaneous position, and it is further intended to represent a history of inventions, a history of prices, a history of industry, and a history of natural productions, so that the world's progress in arts, science, industry, and natural products, will thus be brought into contrast. The Emperor of Austria has granted the use of the "Prater" for the site of the exhibition, and Mr. Scott Russell is at present in Vienna consulting with Baron von Schwarz as to the design for the building. Chevalier de Schaeffer, Director of the Austrian Consulate General in London, who gained great experience at the London and Paris Exhibitions, has been entrusted with the preliminary arrangements respecting the contributions to be sent to the Exhibition from Great Britain.

The objects to be exhibited will be classified in the following twenty-six groups:—1, Mining and Metallurgy; 2, Agriculture and Forestry; 3, Chemical industry; 4, Articles of food as industrial products; 5, Textile industry and clothing; 6, Leather and india-rubber industry; 7, Metal industry; 8, Wood industry; 9, Stone, Earthenware, and Glass industry; 10, Hardware industry; 11, Paper industry; 12, Graphical Arts and Industrial Drawing; 13, Machinery and means of transport; 14, Scientific instruments; 15, Nautical instruments; 16, Military accoutrements; 17, Maritime objects; 18, Architectural and Engineering objects; 19, Cottage houses, their interior arrangements and decorations; 20, Peasant houses, with their implements and arrangements; 21, National domestic industry; 22, Representation of the operation of Museums of Art and Industry; 23, Ecclesiastical Art; 24, Objects of Art and Industry of former times, exhibited by amateurs and collectors; 25, Plastic Art of the present time; 26, Objects of Education, Training, and Mental Cultivation.

Arrangements will be made for temporary exhibitions of such articles which by their nature do not admit of an exposition of long duration.

During the time the Exhibition is held, International Congresses are contemplated for the discussion of important questions to which either the Exhibition itself may give rise, or which may be specially suggested as themes suitable for international consideration.

The arrangement of the Exhibition will be geographical, that is to say, according to countries, but in such a manner that the different territories of production shall appear as nearly as possible in the same order as they are situated naturally in the direction from the west to the east.

SCIENTIFIC USE OF THE MONT CENIS TUNNEL

AT the sitting of the French Academy of Sciences on the 18th inst., M. Elie de Beaumont read an elaborate paper on the scientific instruction which may be derived from a close examination of the collection which is to be exhibited in the School of Mines in Paris of specimens of the strata obtained from the Mont Cenis Tunnel. This collection, which consisted originally of only 127 specimens, has received 69 new specimens, which brings the total number to 196 altogether.

The total vertical thickness of the strata explored was more than 7,000 metres. The general colour is grey, or, rather, black, and the colouring matter is mostly carbon. Very few fossils were met with, having been destroyed by the subsequent crystallisation.

The disturbances which have created Mont Cenis and made it emerge from the bottom of the sea have produced many cracks and faults. But all these faults have been filled up with quartz in a perfect manner in relatively modern times. The infiltration amounts practically to nothing. The only spring which was discovered is situated near Modane, and gives only seven gallons per minute. The water is cold. The contractors were obliged to send to Modane and Bardonnèche for the water required for drinking, and for grinding the stone.

Mont Blanc, although 4,800 metres above the level of the sea, is only 3,500 above its own base. The vertical section of the perforated strata is thus equal to two Mont Blancs; and it is something like one whole Himalaya. M. Sismonda, Professor of Geology at Turin, presented to the Royal Academy of Sciences, Turin, in the sitting of the 5th of December, 1866, a paper entitled *Nuove osservazioni geologiche sulle rocce anthracitifere delle Alpi*, at the end of which was printed a map drawn by M. Sismonda twenty-five years ago, and exhibiting the theoretical succession of strata. Everything was found in the place where it was supposed to be by M. Sismonda.

No artesian well has ever given an opportunity of comparison with the perforation of Mont Cenis, as the deepest bored by European engineers is only 1,000 metres, and by the Chinese only 3,000 metres.

The Academy listened during more than an hour to the lecturer. M. Faye presented to the learned Perpetual Secretary the hearty thanks of the Academy, and expressed a wish that a series of pendulum experiments should be conducted on the top of Mont Cenis as well as in the central part of the tunnel, to test the effect of the mass of the mountain on the time of the oscillations.

NOTES

WE believe that the stations to be occupied by the Eclipse Expedition are Baikul, Gunote, and Manantoddy, near the Malabar coast; Poodoocottah, near Trichinopoly; and Jaffa, in Ceylon. These arrangements are necessitated by the information received as to the weather chances from the Viceroy of India and the Governor of Ceylon, who are taking the warmest interest in the intended operations. It is hoped that Prof. Stokes will take charge of the Expedition, and in this hope we venture to join very warmly. As our leading physicist, as Secretary of the Royal Society and potential President, as one who has so closely studied solar physics and the methods of attack contemplated—on each and all of these accounts it is obviously for the advantage of science that the Expedition should be under his command. The Committee has communicated by telegram with Prof. Peirce, expressing a hope that the Expedition may be strengthened by the addition of some American observers who are all veterans in eclipse matters. Prof. Respighi has also been invited to accompany the party. We must not omit to add that Lord Lindsay has supplied the Committee with many valuable instruments, and is aiding in other ways.

DR. CARPENTER arrived at Malta in the *Shearwater* last week, and has been engaged in conjunction with Captain Nares, commanding that vessel, in a series of researches on the Gibraltar current, intended to complete the inquiries made last year in the *Porcupine*. The existence of the outward undercurrent, which was indicated by the experiments of last autumn, has now been conclusively demonstrated. Dr. Carpenter will accompany the *Shearwater* to Egypt for the purpose of prosecuting in the eastern basin of the Mediterranean the physical and zoological inquiries which he carried on last year in the western basin.

MR. HIND informs us that on Friday night last he secured observations of an extremely faint nebulosity, which he believes will prove to be Encke's Comet, though the predicted time of perihelion may be eight or nine hours too late.

September 22 at $11^h\ 37^m\ 21^s$ Twickenham M.T.
☌ R.A. . . . . . $1^h\ 58^m\ 45^s{\cdot}9$
☌ Decl. . . . . . $+31°\ 22'\ 1''$

This position depends on comparison with one of Bessel's stars extending over more than an hour, during which motion in the right direction for Encke was apparent. Though very faint, it is hardly more so than Mr. Hind expected to find it from previous experience. We may look for a fine telescopic object in November, and one just visible to the naked eye after the middle of the month and in the first days of December, before it gets too near the sun's place to be observable.

THE College of Physical Science at Newcastle-on-Tyne has issued the prospectus of its first session, to open October 7. The following is the programme of studies:—Prof. Aldis will conduct three classes in Mathematics; two for junior students, and one for any who may enter with sufficient knowledge to enable them at once to take up subjects which will in future be ordinarily read by students in their second year. There will also be an Exercise class for all the students. In Experimental Physics, Prof. Herschel will have two classes; the advanced class will contain experimental illustrations of Practical Mechanics, and of Heat considered especially with reference to its application in mining, manufactures, and to the steam-engine; but there appears to be no provision for practical laboratory work. In Chemistry, Prof. Freire-Marreco will conduct both the course of lectures and the practical course in the laboratory. Prof. Page will deliver a course of lectures on Geology, and will accompany the students in field excursions or visits to museums. As yet there is no immediate prospect of a chair of Biology, though we understand its creation is a settled thing as soon as funds allow. The medical degrees at Durham University can now be taken without residence, but an additional year must in that case be made at Newcastle. The College has taken off the hands of the College of Medicine the new lecture room, built expressly for Chemistry and Physics, and the laboratories.

THE Chargé d'Affaires of the Japanese Government in this country, who has looked with longing eyes on Messrs. Cooke's great equatorial, the gem of the present International Exhibition, should also inspect some meteorological instruments for transmission to Japan. The following extract from a little illustrated news-sheet now being hawked about Yedo, giving an account of the late typhoon in the inland sea, and a picture of the appearance of Kobe Bay after it, will show that the Japanese have as yet quite elementary notions in meteorological science:—"The Great Storm-Wave in Kishiu, Idzumi and Setsu.—The sudden changes and movements of heaven and earth are caused by the commingling of the female and male elements, and the contention of wind and rain. Alas! not even can the influence of the gods of Buddah prevail to govern them. It was on the night of the 18th day of the fifth month of the fourth (goat) year of Meiji, and about ten o'clock, that the wind and rain became exceedingly violent, and a great storm-wave arising, not only the steamers, but also about 700,000 large and small boats were thrown ashore at Kinohana and Kumanoura in Kishiu, at Sakai, and at Tempozan off Osaka. At the frightful destruction, old and young, males and females, wept and howled; and the sound thereof was most pitiable. The number of the dead was in proportion to the size of the places (visited by the storm). It was a wonderful event, not heard of in former generations. On the following morning the rain ceased, and the mad wind became quiet, and then for the first time men felt at ease in their heart."

WE have to record the death, in his seventy-ninth year, of the Rev. William Hincks, F.L.S., for many years Professor of Natural History and Director of the Museum in University College, Toronto, and previously Professor of Natural History in the Queen's College, Cork. Mr. Hincks, who had but just resigned his professorship owing to the infirmities of age, was an accomplished and enthusiastic botanist, and had also devoted much attention to certain departments of zoology. He possessed a wide range of scientific knowledge, and through a long life had done much for the diffusion of scientific tastes and culture. Almost to the very close of life he was an enthusiastic student, actively engaged in pursuing his favourite researches, and alive to all that was passing in the scientific world. He published many papers on natural history and other subjects, some of which were specially devoted to the Fauna and Flora of Canada, chiefly in the "Journal of the Canadian Institute." To the Museum connected with University College, of which he was the director, he devoted much time and labour, and rendered it very valuable service. He was an active member of the Canadian Institute, and one of the Editing Committee, which is charged with the publication of the "Journal." In 1869 he was elected president, and was re-elected the following year.

MR. SAMUEL SOLLY, F.R.S., expired suddenly on Sunday last. Mr. Solly was deservedly well known from his numerous contributions to the advancement of science, especially by his work on the "Human Brain," "Surgical Experiences," an "Analysis of Müller on the Glands," and by his various papers and lectures on surgery in the medical journals.

A GERMAN translation of Mr. E. B. Tylor's "Primitive Culture" is in progress. Dr. Spengel is the translator, and the publishers Winter and Co. of Leipzig.

OUR old friend *Cosmos*, the publication of which has been suspended since September last, reappeared on the 10th inst. in a new form, under the title of *La France Scientifique*, still edited by M. Victor Meunier. The new journal takes for its motto, "Régénérer la France par la Science, et la Science par la Liberté." The three numbers already received contain articles original and selected on science and education.

Les Mondes for September 23rd contains an account of an invention by M. Corbin, a sugar manufacturer of Lizy-sur-Ourcq, of a portable railway, which can be laid down daily in any position, and can be used for facilitating agricultural operations, causing a great reduction in the amount of labour required. The invention could evidently be applied only in the case of farms consisting of very large fields, as occurs in some parts of the East of England

THE Zoological Society of London have just received a fine living example of a species of Cassowary new to their collection. It is a young bird, but is probably referable to the *Casuarius uniappendiculatus*, described some years ago by Mr. Blyth from a specimen observed alive in Calcutta, although there are at present no traces of the single throat-wattle, from which the species obtained its name. In general appearance the new acquisition resembles the Mooruk or Bennett's Cassowary (*C. Bennettii*) rather than the Common Cassowary of Ceram (*C. galeatus*). It is said to have been captured on the coast of New Guinea, near the Bay of Geelvink, and was, we believe, obtained by the Zoological Society from one of the sister institutions of the Continent.

IN reference to our article last week on the Smithsonian Institution, we hear that quite recently the learned societies and public libraries of Holland have undertaken to co-operate with the Institution in this enterprise, by forming a Central Scientific Bureau of the Netherlands, at which the packages intended for transmission to America are to be collected, and forwarded from time to time to the Smithsonian Institution, which will distribute them to the parties addressed. The Bureau also proposes to establish special agencies in different parts of Europe, and has already announced the firm of MM. J. B. Baillière and Son, of Paris, as the agents for France, to whom all French institutions are requested to address such copies of their works as may be intended for the Netherlands.

WHEN ocean cables were first submerged, various apprehensions of probable injury were entertained, some of which have proved to be well founded, and others less so. It was supposed that worms or mollusks would burrow in the substance of the envelope, and ultimately penetrate to the centre of the wires; or, again, that the attachment of barnacles, mollusks, or other marine animals on the exterior would invite the attacks of the sharks, rays, and other fish of powerful jaws, and induce them to subject the bunch of matter to such a mastication as should produce serious harm to the cable. To what extent any accidents have happened from this source it is perhaps difficult to say; but we now learn from *Harper's Weekly* that the Florida cable between Punta Rosa and Key West has been injured in numerous places, as supposed by sea turtles biting through or crushing it in their teeth, to such an extent as to destroy its continuity. It is, perhaps, a question whether the turtle be chargeable with these operations; and we think it is quite as probable that, under the circumstances, some ray or other fish has attacked it, and for the reasons already suggested.

A CORRESPONDENT requests us to state that the valuable specimens of *Stagonolepis Robertsoni* and other reptilian remains from the upper Elgin sandstones, which Prof. Huxley has lately examined, are to be found in the Elgin Museum, and not in that of Dundee, as mentioned in our last week's "Notes."

WITH reference to the earthquake recorded in our last number as having occurred in Chile and Peru in June last, a correspondent informs us, that being at that time in Madeira, a perceptible shock was felt there on the 20th about 6 P.M.

M. STROUMBO, a Professor in the University of Athens, has suggested the substitution for some scientific terms in ordinary use of others etymologically more correct. He proposes in particular saccharometer for saccharimeter, eidoloscope for kaleidoscope, rheumatometer for rheometer, rheumatostat for rheostat, apochrose for achromatism, phasmoscope for spectroscope.

AMONG recently started magazines deserving a word of commendation is *The Traveller*, a monthly international journal for England and America, devoted to international topics, real estate and agriculture, and to universal travel. It contains original articles by well-known writers on the various subjects included under the above headings, some of which are illustrated, reviews, notes and queries, correspondence, &c., of a character calculated to interest a variety of readers; and the price at which it is published brings it within the reach of all.

PART II. vol. ii. of the "Transactions of the Entomological Society of New South Wales" is occupied by the first portion of a description, by Mr. Macleay, of a collection of over 1,100 Coleoptera, brought from Gayndah a town on the Burnett River in that colony. Many of both genera and species are new. In this paper Mr. Macleay makes an innovation which he thus refers to in his introductory remarks:—"I have always hitherto, in describing new genera and species, adopted the system most usual with English entomologists of giving these descriptions in Latin. On this occasion I intend to depart from that rule, as I believe that many of those who take an interest in Australian entomology will infinitely prefer the descriptions given in plain and intelligible English."

THREE important papers are reprinted by Mr. V. Ball, from the *Journal of the Asiatic Society of Bengal*—"Notes on the Geology of the Vicinity of Port Blair, Andaman Islands;" "Notes on Birds observed in the neighbourhood of Port Blair during the month of August, 1869;" and "Brief Notes on the Geology and on the Fauna in the neighbourhood of Naucowry Harbour, Nicobar Island."

THERE has been issued, under the auspices of the Accident Insurance Company, an admirable little manual of instruction for the prompt treatment of accidents and emergencies, by Mr Alfred Smee, the eminent surgeon. It is clear, comprehensive, and portable, and the reader is guided in the more important curative processes to which it relates by well-executed and instructive woodcut illustrations.

"HUMAN Locomotion, how We Stand, Walk, and Run," is the title of a lecture delivered last December at Cornell University, by Prof. B. G. Wilder. Dr. Wilder's lecture was profusely illustrated by diagrams and interesting practical experiments. Among other matters he noticed the curious fact that a person never goes in a perfectly straight line for any distance, but always turns to one side or the other, and at last describes a circle and returns to the point from where he started. The deflection is generally if not always from right to left, and is accounted for on the principle that one side of the body tends to outwalk the other. It is a received opinion among American hunters and woodmen that people who lose themselves in forests or extensive plains thus travel in a circle turning to the left.

WE have received a pamphlet on the Economical Production of Peat and Peat Charcoal, as carried on at the works of the Peat Engineering Company, Redmoss, near Bolton, Lancashire. The peat is extracted from the bog, macerated, and moulded by machinery. It is also transformed into a superior quality of charcoal. That the manufacture is a profitable one is apparent from the fact that an acre of peat bog of the average depth of ten feet, will yield sufficient to make a thousand tons of charcoal, which, in competition with wood charcoal, can be sold at such a profit as would alone produce the value of the land from which it is extracted. It is stated that in 1852 the actual annual consumption of raw and carbonised peat in France amounted to 359,319 tons, a consumption which has since largely increased.

THE *Révue Universelle* says that the German Confederation, in acquiring an extended frontier from France, has traced it, not upon a topographical plan, but, in all probability, on a geological map edited at Berlin. In fact, it is to be observed that the new boundaries between France and Germany absorb, for the benefit of the Confederation, all the rich deposits of the mines of oolitic iron in the basins of the Moselle and the Meurthe, with the exception of the Longwy group. Save this, which has been reserved, Germany has made herself mistress of the major portion of the best part of the most important mineral beds in France. These beds extend under the vast plateau which forms the east of the departments of Moselle and Meurthe, and crop out in the valleys from Longwy, in the north, as far as Pont-Saint-Vincent (Meurthe), in the south, and comprise a full quarter of the mineral riches of France. The new determination of frontier will have the effect of introducing into the productive industry of Germany, according to the statistics of 1867, "twenty-three blast furnaces, producing 205,000 tons of metal; 9,000 hectares of iron country, yielding 500,000 tons of ore; fourteen works manufacturing 127,000 tons of iron; and 22,000 hectares of coalfield concessions, yielding 180,000 tons of coal."

THE Maharajah of Bhurtpore has established workshops in which steam is the motive power for the industrial instruction of his people.

ON THE STUDY OF SCIENCE IN SCHOOLS *

BEFORE we commence our regular and systematic study of science, I wish to say a few words to all of you who will hereafter take part in these studies, concerning the nature and character of experimental science, and certain matters connected with the pursuit of it. It will be well to discuss these subjects under the following headings:—

Firstly. The rise and growth of the sciences we are about to study, and their distinguishing features.

Secondly. The objects and aims of the experimental sciences, and the reasons why we study them.

Thirdly. The methods we shall follow for the acquirement of a knowledge of science.

Fourthly. The attitude of mind most favourable to such studies.

As to the first of these divisions, I may mention that the boundary lines of the experimental sciences are very clearly defined. For we find at the extreme limit in one direction the mathematical sciences, mathematical astronomy, mathematical mechanics, and so on; and at the other extremity the classificatory sciences: zoology, botany, and so on. Our course lies between the two limits, where we find the physical sciences proper: statics, dynamics, mechanics, hydrostatics, hydrodynamics, pneumatics, acoustics, heat, light, magnetism, electricity. Chemistry is usually distinguished from these, both on account of the magnitude of the science, which necessitates separate and distinct treatises, and because it concerns the intimate structure or composition of matter, while the physical sciences proper are concerned with unaltered matter. But the term experimental sciences includes both the physical sciences and chemistry, and is hence the most convenient for our purpose.

Most of the physical sciences partake somewhat of the character of the mathematical sciences, while chemistry is on the verge of the mathematical sciences. The physical sciences relate rather to dead matter, to inorganic, unorganised matter, while the classificatory sciences relate to organised living matter: the former to the mineral kingdom (as it used to be called), the latter to the animal and vegetable kingdoms.

Although isolated facts belonging to many of the sciences were known to the ancients, no science can be said to have existed in anything like a complete form for more than 200 years, and several of them are less than a century old. The science of *Statics* treats of the balance of forces, of the relation of the various forces which act upon solid matter at rest. The derivation of the name from ἵστημι is sufficiently obvious. The science commenced with Archimedes (who lived in the third century B.C.), and was greatly developed by Galileo, Bernouilli, and Lagrange. When the equilibrium of fluids is discussed, it is called *Hydrostatics* (from ὕδωρ), and the equilibrium of gases is described under the head of *Pneumatics* (πνεύμα). Hydrostatics owes its origin to Archimedes; you will remember the story of his weighing the crown of impure gold in water, and detecting the imposture; and thus arose that which to this day is called the "law of Archimedes," which asserts that when a body is immersed in a liquid, it loses a portion of its weight equal to the weight of the liquid which it displaces. Stevinus of Bruges, who wrote in the sixteenth century, and Pascal contributed much to the advancement of this science. The reverse of rest is motion, thus there are sciences relating to the motion of solids, liquids, and gases. *Dynamics* (δύναμις) treats of the motion of solid bodies, and of the relation of the forces which produce motion. It originated as a science with Leonardo da Vinci, who, besides being the greatest painter of his day, was an eminent mathematician, engineer, musician, and natural philosopher. He showed that if two forces are represented in magnitude and direction by the two sides of a parallelogram, the resultant is represented by the diagonal of the parallelogram. This is the important principle of the "parallelogram of forces." Galileo added the laws regarding falling bodies; while Newton and Huyghens investigate the laws which regulate centrifugal forces. *Hydrodynamics* treats of the motion of fluids, and bears the same relation to dynamics that hydrostatics bears to statics. The motion of gases is discussed under the science of pneumatics; we have no sciences of pneumastatics and pneumadynamics. Pneumatics dates from the discovery of Torricelli in 1642 that the air possesses weight. Eight years later, Otto von Guericke, of Magdeburg, invented the air-pump, and the science was then developed with great

* A Lecture delivered at Marlborough College as an introduction to the commencement of Science teaching, by G. F. Rodwell.

rapidity. Before the end of the century various treatises on pneumatics had appeared, and perhaps no science so speedily reached maturity. The above sciences, it will be noted, relate to the properties of matter in its three forms of solid, liquid, and gas, when at rest and in motion. We come next to certain sciences which treat of the more subtle and intimate motion of the particles or molecules of matter, with various velocities and in various directions. Beginning with *Acoustics*, we have the vibratory motion of particles across a position of rest resulting in the production of what we call sound. The science of sound, although more or less linked with the art of music, has existed as an experimental science for less than a century. Vibratory movements of the same character taking place in a subtle kind of matter called the ether or interstellar medium, constitute *Heat* and *Light*, the difference being one of velocity, and thus of degree rather than of kind. Finally, we may assume that *Magnetism* and *Electricity* are conditions of matter perhaps not differing much from those which constitute light and heat.

The science of *Light* is certainly one of the older of the sciences. Euclid endeavoured to explain the laws of vision; Ptolemy, the astronomer, wrote a treatise on Light; the reflection of light by mirrors, and its refraction by lenses, were well known facts in the time of Archimedes. Various treatises on the subject appeared during the Middle Ages. The *Ars Magna lucis et umbræ* of Athanasius Kircher, published in the seventeenth century, is a great folio, full of plates. Not long after its publication Newton made the important discovery of the decomposition of light, and treated various optical problems with great precision by mathematical means. Our term *light* is related to the Sanskrit *lok*, to see. Heat has not existed as an experimental science for a century. The science has made great progress during the last thirty years. Heat was once believed to be an entity, a kind of matter, which passed from one substance to another, and which effected certain changes during its transference. We now know that it is simply a kind of motion akin to that which constitutes light, so that it ceases to be matter, and becomes an attribute of matter. It is strange that the term *heat* should be far more appropriate now than it was when heat was regarded as matter, although it was in use long before any theory or science of heat existed. The term appears to be derived from the Sanskrit *indh*, to kindle, through the Greek *αἴθω*, the Latin *æstus*, and the old High German *eit*. "*Æstus*," says Vossius," est commotio vel in aqua, vel in igni, vel in animo, omnis autem commotio fervorem gignit." And the result of modern research has been to prove that what we call heat is, indeed, due to a commotion of particles of matter. Certain properties of heat were well known to the ancients, although the science itself is so young. Thus, Pliny states that the sacred fire of Vesta was kindled by reflecting the rays of the sun by mirrors. The story of Archimedes and the Roman fleet is well known to you. Lenses were known and were used as burning glasses. Aristophanes clearly alludes to the use of a glass lens for obtaining fire; a lens was found among the ruins of Nineveh, and is now in the British Museum. Lactantius states that fire may be kindled by passing the rays of the sun through a glass globe filled with water.

Magnetism has existed for about 270 years as an experimental science. A few magnetic experiments are mentioned by Lucretius, and by Pliny, and one or two Middle Age writers allude to the effects. Of course the mariner's compass, which was known in Europe in the twelfth century, called attention to the existence of the so-called magnetic force. The birth of the science dates from the publication by Gilbert of Colchester of a treatise entitled "De Magnete," in 1600.

Thales, of Miletus, observed that amber when rubbed acquired the property of attracting light substances, and as the Greek for amber is ἤλεκτρον, and the effect had not been observed in other substances, a new science arose called Electricity; but the science has scarcely existed for more than 200 years. The inventor of the air-pump, Otto von Guericke, was also the inventor of the electrical machine. Thus Pneumatics and Electricity were called into existence at almost the same time. Note how essential the invention of apparatus has been to the different sciences. Until experiments could be tried, and until instruments were devised for trying them, the natural sciences made no progress. Voltaic Electricity, or Galvanism, dates from the commencement of this century, and electro-magnetism and dia-magnetism are yet later developments.

We learn from the above remarks that, although some of the fundamental facts of various sciences were known to the ancients, they never developed them. In fact, there was no experimental science among the ancients, they by chance lighted upon a few solitary facts, and with these they were well content. There could be no experimental science among them, for the fundamental feature of this kind of knowledge is, that it depends upon the action of the mind upon matter, while the ancients preferred to exercise their intellects upon things not external to themselves. Physical philosophy is distinguished from mental philosophy by the fact that the former is based upon observed results obtained by the action of the mind aided by experiment, upon external matter, while the latter is based upon the actions of the mind upon itself according to definite laws instituted by the unaided intellect. The ancients elaborated the most admirable systems of mental philosophy, but they refused to have anything to say to experimental philosophy. We may take the following remarks of Seneca as to some extent an exemplification of the spirit in which the ancients regarded Natural Philosophy:—"The astronomer tells me of Saturn and Mars in opposition, but I say, let them be as they will, their courses and their positions are ordered them by an unchangeable decree of fate. Either they produce and point out the effects of all things, or else they signify them. If the former, what are we the better for the knowledge of that which must of necessity come to pass? If the latter, what does it avail us to foresee what we cannot avoid? So that whether we know or not know, the event will still be the same;" as if he said in the language of more modern science, "I am assured that the specific gravity of iron is somewhat more than that of manganese, and somewhat more than that of copper, but I know they are immutable, and it hence matters not how they differ." Or again, "I am told that there are iron and sodium in the sun, but I can never be there to verify it, therefore it cannot concern me." The ancients were content with the truths which they possessed, and cared not to seek for the discovery of new truths. Thus, as I before said, they possessed no system of experimental science.

You will perhaps ask me why physical truths cannot be discovered by means of the unaided intellect. Why is experiment necessary? We must remember that our senses, although infinitely more perfect than our most delicate and refined scientific instruments, are limited in their capabilities. They are devoted to the service of our organisms, and exist for the purpose of enabling us to fulfil all the conditions requisite for the maintenance of life, and to make us cognisant of the external actions of the material world. But this latter function they exercise only to the necessary extent. There are numberless phenomena beyond the direct cognisance of the senses; there is, if I may so express it, light which is unseen by the eye, sound which is unheard by the ear, heat which is unfelt by the nerves of touch. I mean there are physical actions of the same nature as those which constitute light, sound, and heat, which we cannot directly recognise. It then becomes necessary to call in the aid of experiment and of various instruments to assist and exalt the action of the senses. We have a familiar example of this in the microscope. A speck which the unaided eye recognises with difficulty, is seen by exalting the capabilities of the eye in one particular direction to be a perfectly organised being, possessing many of the functions of creatures far higher in the scale of animal life. One of the Infusoria measures about the twenty-two thousandth of an inch in diameter, and can only be seen by the aid of a powerful microscope, yet it is a perfectly-organised creature. So also, when we wish to examine the various properties of matter, it is absolutely necessary for us to aid the intellect and the senses by means of instruments and experiments. The properties of matter were utterly unknown to the ancients, because they relied upon the unaided intellect, and disdained experiment. Numberless effects in nature reveal themselves only when an unnatural and forced condition is imposed upon matter. "Occulta Naturæ," says Francis Bacon, "magis se produnt per vexationes artium quam cum cursu suo meant."

Although many observers existed before the seventeenth century, there were but few experimenters. Observation, experiment, and reasoning, must go hand in hand, before experimental science can progress. We first find this combination in a very marked degree in Galileo, a professor in the University of Pisa, who was born in 1564, and wrote in the early part of the next century. He invented the telescope and thermometer; demonstrated the theory of Copernicus, which asserted that the sun is the centre of our system, and that the earth moves round it; discovered the satellites of Jupiter and the spots on the surface of the sun, and, in a word, made the first real progress in many of the sciences. Galileo is often called the "Father of the Experimental Sciences;" it is certain that he was the first experimental philosopher worthy of the name. The science work of the seventeenth century was altogether prodigious; at no time has so much been effected; indeed the greater number of the sciences sprang into existence at this time.

Science was greatly promoted by the establishment of Scientific Societies about the middle of the century. Literary Societies had existed in Italy long previously; these consisted of a number of members who met together at stated intervals for the discussion of literary matters, the recitation of poetry, and the reading of essays. The names of some of these societies were sufficiently curious; thus we find, among others, the following:—the Grieved, the Fiery, the Dispirited, the Solitary, the Rough, the Unripe. Baptista Porta founded the first scientific society in 1560, and called it the "Academy of the Secrets of Nature;" but on account of the privacy of the meetings, and the prevalence of occult and forbidden arts at this time, it came to be believed that the members used magical and diabolical influences, and the society was dissolved by the Pope. Shortly afterwards Porta published his "Natural Magic," in which he endeavours to prove that the magic of Nature is as wonderful as the magic of Art; in a word, that we find in the phenomena of Nature results quite as wonderful as those produced by professed sorcerers. After the dissolution of Porta's Academy, we find no scientific society until the formation of the Academy of Cimento in Florence, in 1567. This Society was not founded for the discussion of theoretical, or even simple observational science: "our sole design is to make experiments and to relate them," says the secretary at the commencement of the proceedings. Consequently, although the Society flourished for no more than ten years, a volume of "Experiments made in the Academy of Cimento" appeared in 1667, and from its importance it was speedily translated into Latin, and into most of the languages of Europe. It contains a number of experiments relating chiefly to pneumatics and heat.

About the year 1658, a few Oxford men, interested in science, agreed to meet in each other's rooms once a week for the trial of experiments, and for the discussion of scientific matters. The number of members increased, and after a while the meetings were removed to London, and were held in Gresham College. Soon afterwards the society was incorporated by Charles the Second, under the name of the "Royal Society for Promoting Natural Knowledge." Note the significance of the term *Natural* as here employed. There was so much unnatural science in the world, so much magic, witchcraft, false knowledge, that the society thought it well to specify "Natural Knowledge." We find traces of the magical lore of the age in the accounts of early meetings of the Society; thus we find in the minute-book of the Society the following entries under the year 1660:—

"June 5th. His Grace the Duke of Buckingham promised to bring into the Society a piece of an unicorne's horn.

"July 14th. A circle was made with powder of unicorne's horn, and a spider set in the middle of it, but it immediately ran out several times repeated. The spider once made some stay upon the powder.

"June 26th. Dr. Ent, Dr. Clarke, Dr. Goddard, and Dr. Whistler, were appointed curators of the proposition to torment a man presently with the sympathetical powder.

"June 10th. The fresh hazell-sticks were produced, wherewith the divining experiment was tried, and found wanting."

This Society continues to meet weekly, and in its Transactions may be found all the most important scientific memoirs which appear in this country. The Académie des Sciences was founded in Paris a few years after the Royal Society of London.

The influence of scientific societies on the influence of experimental science has been, and still is, very considerable. Towards the end of the seventeenth century they were very generally dispersed throughout Europe, and experimental results accumulated at a rapid rate. They were embodied in text books, and were soon introduced into the Continental universities, and thus became incorporated with general learning. No place in the world has taken so prominent a part in the furtherance of experimental science as the University of Leyden. Its professors during the seventeenth century were renowned throughout Europe, and students flocked from every part of the Continent to the University. Again, it is a noteworthy fact that the first text book of physical science, and the first text book of chemistry, both issued from this university:—the *Physices Elementa Mathematica* of S'Gravesande, and the *Elementa Chemiæ* of Boerhaave. They each consist of two well-illustrated quarto volumes, and were published during the first half of the last century. The greater number of the sciences are made up of the discoveries of the last two centuries, and these will come under our notice when we study the special science itself. I may, therefore, safely leave our brief survey at this point.

(*To be continued.*)

SCIENTIFIC SERIALS

THE *Révue Scientifique* Nos. 8—12 has been to a large extent occupied by a report of the most important papers read at the recent meeting of the British Association; but we find in addition the following valuable articles:—A report of the very important course of lectures delivered by M. Claude Bernard at the Collége de France "On the Action of Heat on Animals;" report of a course of lectures by M. Gréhant "On the Renewal of the Air in the Lungs," largely illustrated by woodcuts; a paper by M. Onimus on *Les nerfs trophiques*; and a number of other papers chiefly bearing on physiological subjects, either translated from the English, or extracted from the proceedings of learned societies. Copious extracts from Mr. Darwin's work "On the Descent of Man" are also translated from time to time.

Der Naturforscher, Nos. 31—34, August 1871. This journal is entirely made up of articles and abstracts from German, French, English, and Italian serials. Some of the latter are especially interesting to us, as being less known in this country. In the first number we find some researches by Prof. Nobbe of Tharand on the function of potassium salts in the nutrition of plants. The experiments were made on buck-wheat and rye; they led to the conclusion that potassium is quite indispensable to the assimilation of plants; without it no starch is formed in the chlorophyll-granules, and the weight of the plant remains constant, exactly as in pure water. Neither sodium nor lithium can replace potassium, the lithium being positively pernicious. An article giving the results of the second German Arctic Expedition describes the climate of East Greenland, where the ground appears to be for three months free from snow, and covered with abundant herbage, fed upon by the reindeer and the musk-ox. The latter was not before known to inhabit this region. From an account of the water supply and soil of the town of Zurich, we learn that in the cholera epidemics of 1855 and 1867, no confirmation could be found of Pettenkofer's theory with respect to the connection of cholera and "Grundwasser." Prof. Nöbius of Kiel, discusses the nutrition of deep-sea animals, especially in relation to the organic "slime," which he believes to be chiefly of vegetable origin. Prof. Karsten related to the Austrian Pharmaceutical Conference in Vienna his personal experience of the poisonous properties of the famous manchineel tree (*Hippomane manzanilla*) of the West Indies and tropical America, which have been doubted by some naturalists. Being engaged for some hours in collecting its juice, Karsten was attacked with burning sensations of the skin, swelling of the face, eyes, &c., which compelled him to pass three days in total darkness. He attributes these effects to a volatile poison given off by the tree. Other papers are: Nyland "On the Phenomena of Discharge of Induced Currents of Electricity;" Fritsch "On the Geological History of the Santorin Group;" Meunier "On the Cosmical Relations of Meteorites, and the Black Colouring Matter of the Meteorite of Tadjera;" Secchi "On the Solar Protuberances;" Young "On the Corona;" Klocke "On the Growth of Crystals," &c. The following papers on physics are from journals little read in England:—"The Heat given off by Incandescent Platinum," by Prof. Garibaldi of Genoa. He used, as Tyndall in his experiments on the electric light, a thermopile, but let the rays pass through a dry vacuum tube closed with thin plates of rock-salt, and absorbed the light rays by a solution of iodine in carbon disulphide. In this way the errors arising from the passage of the rays through a moist atmosphere and through prisms and lenses of rock-salt are avoided. He finds the ratio of visible and invisible rays given off from white hot platinum 1 : 25; but there was still some loss of the dark rays. (Il nuovo Cimento; ser. 2; tom. iii.) In another research, Garibaldi has investigated the power of absorption for heat of the constituents of the atmosphere. The source of heat was heated platinum, and radiation took place through a closed vacuum, thus avoiding some of the errors of other experimenters. The power of absorption possessed by aqueous vapour was found to to be 7,937 times that of dry air. A valuable paper by Kundt ("Würzburger Verhandlungen." Neue Folge, vol. iii.), discusses the anomalous dispersive power for particular parts of the spectrum possessed by certain coloured substances as hæmatin, chlorophyll, sandal wood, litmus, &c.

SOCIETIES AND ACADEMIES

BRISTOL

Observing Astronomical Society.—"Report of Observations to August 31." *Solar Phenomena.*—Mr. T. W. Backhouse, of Sunderland, reports as follows:—"A fine group of spots passed the sun's centre in the southern hemisphere on the 17th August. I made the following measurements of its chief spot:—

Date	H.	M.	Umbra Length	Penumbra Length	Penumbra Width
August 11	21	20	——	82,000	46,000
,, 13	21	20	——	71,000	abt. 18,000
,, 14	3	30	14,500	——	——
,, 14	20	0	16,500	66,000	——
,, 15	21	15	16,500	65,000	34,000
,, 18	3	30	9,500	59,000	39,000
,, 20	21	0	——	75,000	——
,, 21	21	20	smallish	divided into four	——

The penumbra had a more ragged appearance than is often the case. If this group has returned to this side of the sun it contains no important spots this month. It generally contained two or three large penumbræ, of which I made several measurements, and on the 18th they were united at 3h 30m, making a penumbra 78,500 miles long and 41,000 wide at its widest part, and at 21h 10m 84,000 miles long. By the 25th all its spots were so reduced as to be quite small."

The Moon.—Mr. Albert P. Holden, of London, writes:—"Shortly before last quarter of the moon in August I observed the unilluminated portion unusually bright with earthshine. A few prominent craters could be traced, whilst the whole of the dark outlines of the *Mare Serenitatis* were easily recognised. The darkest object was the *Mare Crisium*, which appeared almost black, and very considerably darker than any other of the great plains. It does not seem improbable that the depth of colour seen in the *Mare Crisium* and other planes may be due to a covering of alluvial earth, to which vegetation may at times give the greenish tinge occasionally observable.

August Meteors.—These phenomena were observed by the Rev. S. J. Johnson, at Crediton, and Mr. William F. Denning, at Bristol. On August 10 Mr. Johnson witnessed the appearance of shooting stars at the rate of twenty-six per hour. Mr. Denning maintained a watch during three evenings, and the average number seen per hour was as follows: Aug 9, 18; 10, 28; 11, 46. The maximum number was seen on the latter date. He observed 260 meteors altogether during the above dates, and the sky was under observation for a period of 8¾ hours. The most brilliant meteors were observed at 12h 23m on Aug. 10, and at 10h 44m and 12h 50m on Aug. 11. Very nearly all the meteors observed radiated from the small star β in Camelopardalus. Nearly all of them were accompanied by trains, which became extinct immediately after the disappearance of the meteors themselves.

The Nebula in the Pleiades in Taurus.—Mr. Albert P. Holden has again endeavoured to pick up this object with his 3-inch refractor, but without success. "With good eye-sight and a clear atmosphere I have failed to find the slightest trace of the nebula on all occasions. I have no hesitation, therefore, in saying that in instruments of 3-inch aperture and under, the object is utterly invisible. I beg some member of the society to search for this object with larger instruments, so that the question as to its actual disappearance may be beyond dispute. It is important that this question should be set at rest at once, because in the event of the nebula brightening we should certainly regret not having decisively established the fact of its disappearance.

DUBLIN

Royal Irish Academy, June 12.—The Rev. President Jellett in the chair. Profs. Sullivan and O'Reilly read "Notes on the Great Dolomite Bed of the North of Spain in connection with the Tithonic Stage of Prof. Opel." (This paper was erroneously referred to as read on the 22nd of May, vide *ante*, p. 136, where for "Opal" read "Prof. Opel.")—Dr. Sigerson read some additions to the "Flora of Botanical District No. 10 (Ireland)," and on an anomalous form of the Corolla of Erica.—Bryan O'Looney read "Notes on Lebor na h-Uidhri," and G. J. Stoney and J. E. Reynolds read a paper on the "Absorption Spectrum of Chlorochromic acid." The following were elected members:—W. A. T. Amhurst, D.L. Norfolk, Captain R. Cooper, Rugby, Whitley Stokes, Calcutta, and Colonel Tyrrell, J.P., Londonderry.

June 26.—Rev. President Jellett in the chair. Dr. Sigerson read "Note on the Remains of Fish in the Alluvial Clay of the River Foyle."—Rev. Dr. Reeves read a paper on the "Topography of the County of Armagh."—Mr. G. J. Stoney, F.R.S., read "Notes on a New Form of Spectroscope."—Mr. W. H. Hennessy read a paper on the "Tale of the Brudin Da Derga contained in the Lebor na h-Uidhri," and Dr. Hayden read "Notes on the Respiration of Compressed Air."

PARIS

Academie des Sciences, Sept. 18.—M. Faye in the chair. It was stated that the total amount of money in the hands of M. Janssen for the scientific expedition to Sumatra to observe the solar eclipse in December next will reach to 1,580*l.*—Several gentlemen sent letters describing the earthquake which was felt in Burgundy on the 9th of September, 7.45 A.M. At Tranant a number of fences which were piled together were overthrown in a straight line, making a deviation of 27° W. from the magnetic needle.—M. Combary, director of the Constantinople observatory, sent a note to describe the extraordinary cold felt in last May. In Yorkshire it was felt on the 12th, at Paris on the 15th, at Constantinople on the 18th. The perturbation, which lasted for some days, was felt also in Arabia, where the torrid deserts were affected by cold.—M. Leverrier read a letter from Barceloneta describing the observations, which were made with more care than anywhere else in France, on the falling stars of the November display of 1869 and 1870.—Several communications were made relating to analogies exhibited by spectra of different substances belonging to the same family of chemical substances.—M. Delaunay read a note on the discovery of a new planet observed in the Marseilles Observatory by M. Borelly on the 12th of September, 1871. It is the 116th, and is to be called *Lomia.* M. Borelly had discovered already the 91st, 99th, and 110th, and has given to them respectively the following names: Egine, Dike, and Lydia.—Communications relating to the cholera were three in number, and were all sent to the committee for the Bréaut prize, which is a sum of 4,000*l.*—A table placed before the chair was covered with samples of rocks extracted from Mont Cenis Tunnel, and arranged in a systematic collection, which will be exhibited in the museum of the School of Mines. M. Elie de Beaumont, the perpetual secretary, read a very long paper on the instruction conveyed by this collection, the most important portions of which will be found reported in another column.

BOOKS RECEIVED

ENGLISH.—Experimental Mechanics R. S. Ball (Macmillan and Co.).—The Lichen Flora of Great Britain: Rev. W. A. Leighton (Shrewsbury, printed for the Author).—Miscellanies of John A. Symonds, M D: Edited by his Son (Bristol, J. Arrowsmith).—The Soldier's Pocket-book for Field Service: Col. Sir G J. Wolseley (Macmillan and Co).

FOREIGN.—Archiv für Anthropologie, 4er Band.

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